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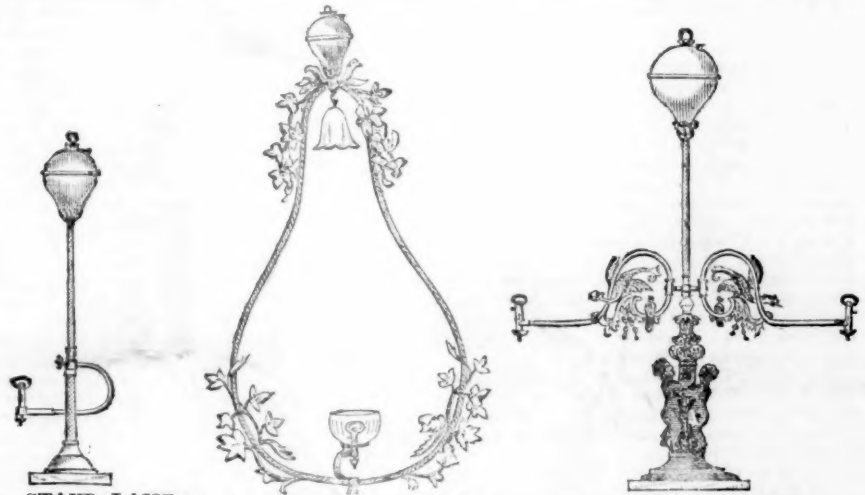
Novelty Portable Gas-Light.

Since the discovery of petroleum in such abundance, refiners, in order to make it fit to burn in wick-burning lamps have found it necessary by peculiar distillations to separate the hydro-carbons, or oils of light gravity, in order to secure the heavier grades fit to use in the common lamps of commerce above referred to. The oils of light grade being more of the nature of camphene, and so highly combustible as not to be safe in common or wick lamps. Hence these light oils became a drug in market, and formerly many thousands of barrels were allowed to run to waste. Inventors have made many efforts to produce a lamp or apparatus in which these light oils could be burned with safety, but never have fully succeeded, until the Novelty Portable Gas Lamp was invented and perfectly adapted to this purpose.

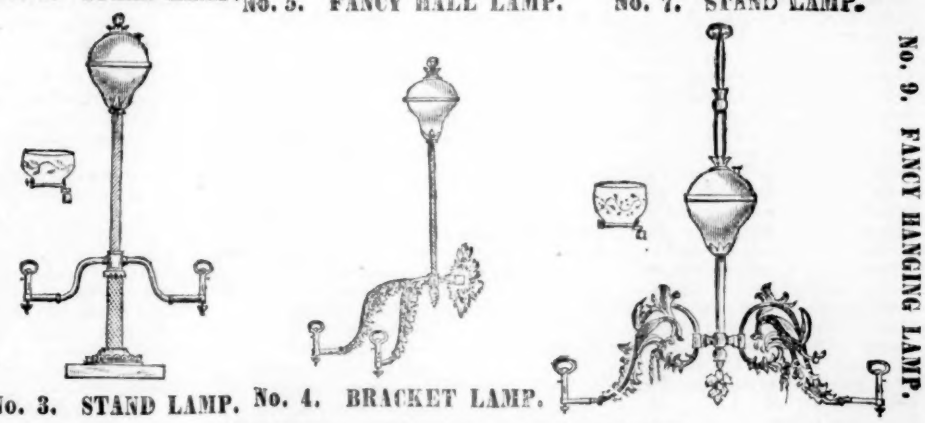
It is a perfectly scientific apparatus, consisting of a brass oil receptacle or fountain, with a descending tube or tubes, and lateral projecting arms, in the various forms of gas fixtures, such as brackets, pendants, chandeliers, table candelabras, etc., quite similar to ordinary gas fixtures, as will be seen by referring to the engravings herewith given. The burner is the most peculiar feature, being a short copper tube, with a screw valve at the bottom to admit a small jet of vaporized oil, which, on the principle of the "Gifford Steam Injector," draws in, through suitable openings, air which mixes in proper proportion, to produce highly illuminating gas, which burns at the top of the tube with a bat's-wing flame, similar to ordinary city gas, but far more brilliant, and at much less cost. The flame, by means of peculiar rings or heaters, as shown, conducts heat to the tube of the fixture, where it is screwed on, so as to constantly evaporize the oil, and continue the process.

Supplementary heating flame jets are sometimes used, dispensing with the ring or heaters. This is really a wonderful invention, quite distinct from the burning-fluid or vapor-lamp in use some years ago, before petroleum was in use. The light is so similar to ordinary gas it is difficult to distinguish the difference, and the similarity of fixtures aids the deception. Its advantages are quite remarkable on some accounts. It requires no piping. It is portable, if desired, like a hand lamp. The light oils burned in it are very cheap and abundant, and the cost of the light less than any other known to-day, being about one half the cost of coal oil or petroleum. A few of the various styles and devices are shown herewith.

For further particulars address, "Novelty Gas-Light Company," 22 Pine street, who desire to have agents everywhere, and will sell State and County Rights, etc., and supply fixtures, etc.



No. 2. STAND LAMP. No. 5. FANCY HALL LAMP. No. 7. STAND LAMP.



No. 3. STAND LAMP. No. 4. BRACKET LAMP. No. 9. FANCY HANGING LAMP.

NOVELTY PORTABLE GAS-LIGHT.

Another Cable.—A French company has been organized to lay a cable from Marseilles to Corsica, which will probably be extended to Algiers, and ultimately along the north coast of Africa to Suez.

The Bursting of Water Pipes.—Does water expand on becoming ice? *Scientific Opinion* asks this question, and says:—When a bottle of water is frozen the bottle is usually burst. Hitherto this has been explained by the assertion that the water, on solidifying, suddenly expands. Mr. Barthélemy, one of the professors in the Lyceum of Pau, denies this explanation. In a memoir which he has written on the crystallization of water, he alleges that bursting of the bottle is caused by the disengagement of a large quantity of gas—hitherto in solution—by the water at the moment of its solidification. It is alleged, in support of this, that if a bottle of water be placed outside a window in frosty weather, it will be observed that the rupture takes place at the hottest side, viz., that next the window. Some of our correspondents may have made experiments on this point, and we shall be glad to hear what they have to say to this opinion.

Explosion at the Rochdale Gas Works.—The London *Builder* of Nov. 14th contains the following account of a dreadful explosion which occurred recently at the Rochdale (Eng.) gas-works: "A workman cautioned another that there was a "back pressure" on a new meter in course of fixture in a part of the works recently built to increase the supply, and the hole was plugged up with a wooden plug. Either forgetting or neglecting the caution, the workman pulled out the plug at the back of the meter, and the gas then passed without obstruction from the gasholder into the purifier, and thus into the building, where a number of workmen, employés of Mr. Charles Bigmore, of Stockton, were engaged in painting the purifier. The gas ignited, and a terrible explosion took place. The inside of the building was one volume of flame, and the workmen with difficulty managed to get out alive. Some of them were frightfully burnt. As the building and roof were both fireproof, the flames gradually died out, and the works and the building sustained but little damage

The Gas Companies and the Board of Health.

OFFICE OF THE METROPOLITAN BOARD OF HEALTH,
No 301 Mott Street,
New York, February 13th, 1868.

In the matter of the application of OSCAR ZOLLICOFFER, *for the modification of the order No. 425, dated July 14th, 1868, of the Metropolitan Board of Health, concerning the business of Manufacturing Gas, at the foot of West 42nd Street, New York.*

CONTINUATION OF THE HEARING BEFORE S. C. HAWLEY.

Ex-Judge H. C. Van Vorst appeared for the Metropolitan Gas Company.

J. S. Hastings, and George Bliss, jr., appeared for the Board of Health.

Professor *Benjamin Silliman*, re-called. Examination resumed by Judge Van Vorst:

Q. Professor Silliman, you spoke about having visited the Gas Works in Boston, Philadelphia, and in some other places—state, if you please, in what part of the city those gas works are located, as to their being surrounded by population? A. The densely peopled part of the old town of Boston, is the location of the gas works there.

Q. How in the other places? A. The Northern Liberties Works in Philadelphia, which is an independent corporation not owned by the city, is also in a densely settled portion of the town; there are, at present, I believe, three distinct gas works in Philadelphia, not under the management of the corporation; I have not visited all of these; but one of them certainly, is in a thickly settled portion of the city. The Manhattan Works, as everyone knows, is in a very densely settled part of the town; so is the old works of the New York City Company.

Q. You mentioned that, in the gas delivered by the oxide of iron process of purification, there was remaining the element of sulphur, the same having been imperfectly extracted? A. I stated that the iron process failed to remove sulphur to the same complete extent, to which the dry lime process removed it; but there is some remaining—a portion of what is not called the free sulphur—which would not have been there, if the other process had been adopted; that, I beg to say, is entirely independent of any chemical combination in the gas, and makes its appearance only when the gas is burned.

Q. That is not developed until combustion takes place? A. No, sir. The other is that which is in a state of such chemical combination, that it gives to the gas manufactured, an ocular evidence of its presence by staining the paper.

Q. Can that be discovered by testing it with lead paper in a dwelling house as it comes from the pipes? A. If the gas is imperfectly purified.

Q. What, if any other defects, are there incidental to the oxide of iron process of purification—state them if you please? A. I can conceive a greater objection to the iron process, than the small residue of sulphur which is left, is to be found in the carbonic acid, which the iron fails to remove from the gas. It is well known to all who are familiar with gas, that the presence of this small proportion of carbonic acid, greatly reduces the illuminating power of the gas; and that it also, in a corresponding degree, diminishes the temperature of its combustion; I consider this a great defect, for two reasons, that in the first place, it is the bounden duty of all gas companies to render to the community, the best possible illuminator, and they fail in their duty when they fail to do this; second, the presence of the carbonic acid alluded to, involves another danger, namely: the imperfect combustion of the gas, with more or less acetylene and carbonic oxide, or oxide of carbon; the carbonic oxide is one of the most poisonous of gases—far more so, one hundred times more so, Dumas says, than carbonic acid, which is commonly reputed a poisonous gas.

Q. Where the oxide of iron fails as a purifier, in this regard, the lime process succeeds? A. The lime process is perfectly successful in the removal of the whole of the carbonic acid; and if it fails to do so in any case, it is simply from a slovenly application of the method; I can conceive that this feature of the iron process is its essentially weak point.

Q. Would you, as an expert, and chemist, advise the Metropolitan Gas Light Company, to do away with the lime process of purification, and adopt, in preference to it, the oxide of iron purification for any reasons? A. I could not say; I should like to add a qualification to that: provided the Metropolitan Company take all needful and proper precautions to avoid the just causes of offence and complaint, which exist against the lime process, when not carefully conducted.

Q. You have ventured that modification in your answer, and I, therefore, will ask the question of you: what improvements could you suggest to the Metropolitan Gas Light Company, in the way of the manufacture and purification of gas? A. Granting that the surface area of their lime purifiers is adequate to their daily production of gas—which is a point about which I am not fully satisfied—the one important thing needful for them to do to avoid all just causes of complaint, is, in my judgment, that they should adopt a system of ventilation by atmospheric air, drawn by an exhauster through a box containing the spent lime after its cover has been raised, so that the atmosphere may have access, and before the process of oxydation—previously described at our last session—has set in, and the conveyance of the contaminated atmosphere drawn by the exhauster to another set of lime boxes charged with ventilated lime, which lime has been found, by a frequent experiment—a constant daily experiment at the Manhattan Works—adequate to the complete absorption of all the offensive odors which are, otherwise, exhaled into the atmosphere. This process, properly conducted, leaves the lime in the exhausted box, in a condition of sulphate, or sulphite of lime and carbonate of lime—with a portion of unexhausted hydrate of lime, which is always present to a noticeable extent; this mixture is completely inoffensive; and may be left exposed to the atmosphere, without annoyance to anyone, and constitutes a valuable fertilizer which may be safely applied at once, in the business of agriculture; whereas, as is well known, the ordinary spent lime of gas works, requires a long process of exposure, in order that it may not be rather injurious than beneficial to the farmer.

Q. What is the quality of coal that the Metropolitan Gas Light Company uses in the manufacture of gas? A. I made particular inquiry last week, when at the works, with reference to this matter, and I found in their sheds the best qualities of bituminous coals. They were using, at that time, as their stock coal, the Westmoreland of Pennsylvania, which the best manufacturers of gas are pretty well agreed is one of the best coals accessible to the Atlantic border. They use, also, the Boghead cannel, which is universally esteemed as the richest of all the enriching coals. They had, also, the Lesmahago cannel, which stands next in commercial value and in illuminating power, to the Boghead. They had, also, several other of the more esteemed varieties of the European cannel coals, but as I understand from Mr. White, the chief engineer, they were depending chiefly for the enriching of the quality of the gas, upon a mixture of Lesmahago and Boghead. I failed to mention by name one of the other coals which should be be mentioned particularly, as it is in constant use there— the well known Wigan cannel.

Q. What length of time would it take for the purpose of making those improvements, that you suggest for the ventilation of lime? A. Those improvements would require the construction of another house to contain the oxidating boxes; and its construction with the necessary underground works for the exhausters, I should think would require two or three months. That question, I should think, is one which would be better answered by the engineer of the company; for the conditions under which the work can be done, may require that it be done in the summer—that is it may not be possible to do it while the ground is frozen.

Q. Do you know B. Howard Rand, Professor of chemistry in the Philadelphia college of medicine, and lecturer upon chemistry in the Franklin Institute? A. Yes, sir—he is well known. I am not certain as to his being in that Institution.

Q. What is his reputation as a writer and lecturer on chemistry? A. He is a good chemical authority.

Q. I have before me an answer of Mr. Rand's, in these words: "I do not believe that the odors arising from the refuse water and the other residuary products of gas manufacture, are, or may be injurious to health when the dry lime is used in the purifiers and is then exposed to the air and light. Sulphuretted hydrogen or hydro-sulphuric acid gas is disengaged. When the well containing ammoniacal liquor is allowed to remain uncovered, ammonia and hydro-sulphate of ammonia are given off. That these gases, however, although offensive to most persons, cannot be considered as causes of disease or injurious to health, when freely diluted, is shown by the fact that the men engaged in removing night soil as a nightly occupation, do not suffer in health, although exposed to these very gases in a far more concentrated condition than they can exist from the causes already named, and mixed with organic emanations of an equally offensive nature, which would certainly aid the injurious effect of these gases, did any such exist."—Do you agree with Professor Rand? A. I do in the main. I might not agree with the exact transformation he speaks of, but in regard to the sanitary effect, I have expressed myself to that effect in the testimony given last week. I wish to say in this connection, that I do not think the permitting of the escape of those effete products, in densely peopled regions, is not a just cause of complaint, as an offense against the nostrils of the community. This is quite another question.

Q. I am speaking of the matter as to their deleteriousness to health. A. I do not consider them deleterious to health—they may be annoying to comfort.

Q. As to the truthfulness of any charges which are made in regard to the emanations from the Metropolitan Gas Company, as being injurious to the health of the neighborhood—and especially to young persons and such—is there any foundation for such charges? A. I do not believe there is any just ground for any such charges.

Q. You have seen nothing to justify them? A. I have seen nothing to justify that allegation.

Cross-examined by Mr. Hastings, counsel for the Board of Health:

Q. You stated, in your direct examination, that you had been practically familiar with the manufacture and purification of gas for about twenty years, and had studied the subject of its purification, both theoretically and practically—please state what processes of purification you have studied practically? A. My practical experience with the purification of gas has been chiefly with the dry lime, but I have also had some familiarity with the wet lime purification, and I have inspected the iron process.

Q. Did you ever study Laming's process practically? A. No, sir; Laming's process has been brought into general use since I was in Europe, and I have not had an opportunity to examine it practically—meaning by that, studying it in the gas works; I have been familiar with Laming's process as a student in the science of gas purification.

Q. Did you ever study the iron ore process, as used in England, practically? A. No, not practically in the works.

Q. Have you a practical knowledge of any iron process? A. Not of my own experience.

Q. Then your practical knowledge is confined to the lime process? A. My practical experience—personal experience, as an administrator of gas works; so far as I am advised, there is but one, possibly two works, in this country where the iron process is in use; one of these, and the most important, I have examined, but not in the proper sense of the word, practically, as I have not abided there for the purpose of studying it, day by day, as I should do if I was in charge of the works.

Q If not acquainted with the iron process, do you consider yourself fully competent to advise with regard to its use? A. I do; I do not conceive it is necessary for me to have spent months in the gas works in order to reach a safe and trusty judgment; the processes involved in it are perfectly plain and obvious to any chemist; the objections which exist against it I have already stated; and they are such as must meet the assent of every chemist; they are inherent in the very nature of the process. It is a most excellent process up to a certain point, but it fails beyond that point. The English companies have been compelled by law into its adoption; but I know from my reading and familiarity with gas engineers and gas literature, that they would gladly return to the lime process, if it were practicable for them to do so, in densely peopled centres like London; but that there are practical difficulties attending the use of the lime process there, every gas engineer is perfectly free to admit, practical difficulties growing out especially of getting rid of the waste. The iron process offers to the gas companies the important advantage of economy in the administration of their affairs, in that they have not the daily recurring expense of purchasing new quantities of lime, and disposing of it, and, perhaps, at a loss; for when they have once got their stock of iron on hand, it is revived by the oxygen of the air and the chemical transformation, as already explained; and the expense is therefore reduced to the manual labor of handling the material.

Q. This is an advantage to the companies, but it is not necessarily an advantage to the community. What are the practical difficulties in its use, that you refer to? A. Of the iron process?

Q. Yes, sir. A. I have already stated those in my direct testimony, as being, especially the failure of the iron process to remove the carbonic acid.

Q. Give us the outlines, if you please. A. That it fails to remove, as perfectly as lime does, the sulphur; and that in leaving a considerable portion of the carbonic acid in the gas, it not only abases the illuminating power, but reduces the temperature of the combustion, involving the risk of production of carbonic oxide and acetylene.

Q. As a general rule, does not a practical acquaintance with any process tend to correct or modify views you may have formed in advance of its adoption? A. I entered on the study of the iron question without the slightest prejudice in its favor or against it. It is, undoubtedly, true that a practical familiarity with any process may tend to remove objections which are not well founded, but it cannot remove objections which are real and inherent, and in the nature of things. Nothing can alter the properties of carbonic acid.

Q. Not having tested the iron process in its various combinations, are you able to state that the objections you name are well founded? A. On general principles, yes, sir. I agree perfectly, that if the lime process is made supplementary to the iron process to such an extent as that the carbonic acid shall be absorbed by lime, then the good effects of the two processes may be combined; but that is attended by another

and very serious objection of a practical nature irrespective of expense, and that objection is, that the gas suffers a needless loss of its illuminating power. It is a perfectly well accepted principle among gas engineers, that over-purification is a fatal error in the manufacture of gas. It is perfectly well known to chemists who are familiar with this subject, that the illuminating power of gas lies within exceedingly narrow limits, and that the volatile hydro-carbons which are held in a gaseous state in an elastic form in gas, belonging to the olifiant-gas series, are very easily removed from gas by over purification.

Q. In your statement, that over-purification is a fatal error, you restrict it to the illuminating properties of the gas?

A. Yes, sir, certainly—the illuminating properties of the gas. It is very well agreed now among gas engineers, that that error has consisted to a too great extent in the scrubbing of the gas with the water—that the prolonged contact of gas with water, in scrubbing, has had the effect to remove too much of the illuminating power; and the purification process has been seriously modified by the best gas engineers, in the recent times, in the omission, to a certain extent, of the scrubbing.

Q. Does not the scrubbing process tend to remove the offensiveness of the gas..

A. Undoubtedly, but it may be carried too far, as already indicated.

Q. Too far with reference to the illuminating power? A. Not merely that. It may be carried so far as to remove all the free ammonia, and in that case, the gas has not present in it a trace of ammonia to combine with the sulphurous acid formed by the combustion of the sulphur compounds with the production of sulphite, and sulphate of ammonia in place of sulphurous acid.

Q. When and where have you seen green vitriol used in connection with the milk of lime you refer to? A. I should like to suggest a modification of your question, because I did not state that it was connected with green vitriol, for that would be preposterous. I said the two things are used in succession.

Q. You did not mean to state that you have ever known green vitriol to be used in connection with milk of lime? A. Not in the same vessel. This process is in use in Boston, and has been there used, to my knowledge, for 25 years. Since I had the pleasure of meeting you last, I have had an interview with Mr Greenough, President of the Boston Gas Works, who informs me, that they still employ the wet lime process, which process involves, as an essential feature, the partial use of green vitriol—in a distinct vessel, of course. The same process is in use in Providence.

Q. The iron process? A. No, sir.

Q. The wet lime and green vitriol? A. Yes, sir.

Q Is not that an iron process? A. No, sir, not in the sense that gas engineers use it. In the one case you will use sesqui oxide of iron and in the other protooxide of iron. In the one case you remove the ammonia—in the other not.

Q. Then the gas works in Boston and Providence do use a different process from that employed by the Metropolitan Gas Company? A. Yes sir; I so stated in my direct testimony; I believe there are other works in New England that do the same, but those are the only ones I have a personal knowledge of.

Q Where is the wet lime process now used in the United States. A. The places I have just mentioned, to say of my own knowledge.

Q. What is the difference between Laming's process and the iron ore process employed in Europe. A. In Laming's process there was a mixture of lime and sulphate of iron, with a view to the removal of the ammonia and carbonic acid. The iron ore process, as it is employed on the continent of Europe, I have never seen personally, but, as I understand from those who have, it involves the use of the ore of iron—limonite—crushed and reduced to a proper state of powder, and mingled with some inert substance like saw-dust, spent tan bark, or some other inert substance.

Q. Can you state how Laming's mixture is made? A. I have never witnessed the preparation of Laming's mixture.

Q. What are the processes generally used in Great Britain or the continent? A. I think I have already stated in the direct examination that, in London, and on the continent of Europe, the usual process employed, is the iron process; that is a point admitted fully I think.

Q. Why has this process been employed instead of the lime process formerly in use? A. Chiefly from municipal regulations.

Q. What other reasons influence its employment? A. I think the cause which has been most influential, perhaps, with the companies, has been the consideration of economy, on their part. The restrictions in Great Britain, particularly with regard to the illuminating power had been so very low, admitting the use of 12 or 13 candle gas, that it did not signify if there was a certain quantity of carbonic acid left in the gas, inasmuch as I have already explained in a former answer, the cost of the iron process is chiefly in the purchasing and maintenance of the stock, which is but very slowly exhausted and reduced, and is mainly due to the item of manual labor in the manipulation. There is an obvious economy on the part of the companies in their general expenses of administration, in the use of the iron process. They have not to purchase, daily, new quantities of lime, nor to haul away the refuse. It is objected with great force, by Mr. Clegg and others, to the use of the iron process, that its ventilation by the system knowu as Palmer's system, is impracticable, because of the destruction of the apparatus, incidental to the high heat produced by the oxidation of the iron, which is sufficient even to raise the mass to redness.

Q. That objection would apply only to wooden apparatus? A. Yes, sir; I can conceive so; if the temperature rises to redness, it would undoubtedly endanger the purifying boxes, and would agglutinate the material so as to require some more mechanical treatment than the shoveling to reduce it to a condition fit for use.

Q. Has not the question of offensiveness influenced the change from the lime process to the iron process? A. Unquestionably, that has been undoubtedly the principal or efficient cause that has induced legislation on the part of Parliament and municipal regulations, the offensiveness of the lime process. It is offensive—that is what we are all ready to admit.

Q In your reference to municipal regulations what may we understand you to mean? A. I understand that in Europe the police or local magistracy may present a gas company as a nuisance, if they judge, in their opinion, that the case is worthy of it; and that is what I mean by municipal regulations, as it is distinct from the general metropolitan gas act, or Parliamentary act under which the general administration of gas companies is placed.

Q. You would recognize then three distinct processes in present use—the dry lime, Laming's and the iron process? A. I recognize four.

Q. The wet lime also, I suppose? A. The dry lime, wet lime, Laming's process and the iron process. There are, essentially two however—the lime process and the iron process. The others are modifications.

Q. You stated as an objection to the dry lime process, that the accumulation of the effete waste product about the gas-works, as ordinarily conducted, constitutes a just ground of complaint as a nuisance. Do you mean to limit this term nuisance to offensiveness of smell?

A. I do; and I mean also to limit that remark to the lime which is of comparatively recent origin, because in the accumulations about a gas-works, where large masses of effete lime are piled up, it is only a comparatively small portion which is offensive. The same effect takes place in a few weeks by the natural process of atmospheric oxidation which, by ventilation, may be made to take place in two or three hours.

Q. Why, in large gas-works would not this effete lime be exposed every few hours? The ventilators are opened about once a day, as I understand, in the winter season? A. I do not know that I understand what you mean by ventilators.

Q. The purifying boxes, I should say? A. The purifying boxes are opened at least once in twenty-four hours, ordinarily, once in twenty-four to forty hours; but when the purifying boxes are opened for the purpose of ventilation, there is no offense, because the act of ventilation commences instantly with the opening, and a current of air is then drawu inward to the products, so as to conduct them to wards the other lime box where the offensive gases are secured.

Q. As a general rule, does not the introduction of any foreign element into the common atmosphere tend to taint and deteriorate it? A. That is a general question, is it?

Q. Yes, sir. A. Certainly.

Q. Will you state, in the order of their predominence, the constituents of the foul gas lime? A I don't know that I should be able to do so with accuracy from memory, as it is a pretty complex mixture; but I would mention the sulphide of calcium, and the sulphide of ammonium, and the carbonate of lime, and the unexhausted hydrate of lime. Various compounds containin, cyanogen, naphthaline, sulphuretted hydrocarbons, gas-tar, probably phenol, or other analogous compounds, carbonic disulphide. This last product is commonly esteemed one of constant presence in the effete products of gas distillation, but I have reason to believe that it is not so commonly present as is supposed, from my own experiments. This is a general statement of what I conceive to be the important constituents present in the effete lime, prior to oxidation, while the box is yet closed, before atmospheric oxidation sets in. This effects important atmospheric transformations not here considered.

Q. This carbonic disulphide is identical with bisulphide of carbon? A. Yes,s ir.

Q. What gases are evolved from this mixture when exposed to the action of the air? A. The first effect of access of atmospheric air to this mixture is that of oxidation, accompanied by a considerable elevation of the temperature, and the transformation of the previously existing compounds into new states.

Q. Watery vapor is exhaled in considerable quantity, carrying with it sulphide of ammonium and free ammonia vapor of naphthaline and the vapors of various other hydro-carbons? A. I have answered this question in my direct examination, perhaps with sufficient fullness; I called attention in my direct examination to the important fact as touching the question at issue in this suit, that the vapors or exhalations, or gases ifyou please, which are given off from the effete lime vary in the different stages of the progress of the oxidation or transformation; that the first and overpowering impression which is made in the incipiency of this act of oxidation, is that of ammonincal vapors, whether free ammonia or sulphide of ammonium, completely abasing and overpowering all other impressions; that the naphthaline odor is also easily recognized, but that the peculiar disgusting, heavy persistent odors which give to the gas lime its abominable smell, do not make their appearance until a later stage of the process; and that these odors are often more distinctly perceived at a little distance from the works—I would rather say at a considerable distance from the works—than near at hand, while on the other hand the ammoniacal odors, and the other odors connected with the ammonia disappear at no very considerable distance; in evidence of this I called the attention of the Board at the last interview, to some test paper which had been exposed to the action of the atmosphere in the yard of the Metropolitan Gas Works, showing that the radius, measuring from the purifying house, upon which perceptible effects of sulphur vapors could be detected, did not exceed one hundred feet when the wind was blowing strongly in the direction of the paper from the purifying houses.

Q Which, if any, of these gasees are poisonous? A. What do you mean by poisonous. Oxygen is poisonous.

Q. In the broad sense; not necessary fatal to human life, but poisonous in tendency. A. There is no gas which taken alone may not in the strict sense be esteemed a poison. An animal will die if immersed in pure oxygen and quickly if immersed in pure nitrogen by suffocation, yet the two gases together constitute the beneficial atmosphere in which we live. An animal will die if immersed in ammonia vapor, or in vapor of water, or in carbonic acid, either by direct suffocation or by specific poisonous influence. If by your question you intend to imply that either of the gases given off by the effite lime is exhaled in quantities sufficient to act as a poison, I take exception to the theory implied by the question, sulphide of ammonium is undoubtedly a poison, in that a small quantity of it comparatively will destroy life. The same is true of ammonia; the same is pre-eminently true of carbonic oxide. But these substances are often all present in the atmosphere, even of the purifying house in relatively very small proportions, and I appeal to the universal experience of the dry lime process of purification everywhere within my knowledge and reading, for the absence of any evidence tending to show that and poisonous influence is exercised by these gases upon the health of persons frequenting those places and the places most exposed to them. I have yet to learn of the first instance of personal suffering, except in the single case mentioned last week, of the irritation of the eyes where persons were exposed to ammoniacal vapor, and that was entirely transitory.

Q. When exposed to the air, what becomes of ammonia? A. Free ammonia will speedily combine with carbonic acid in the atmosphere. Free carbonate of ammonia dissolves in the watery vapor of the atmosphere, and is diffused and lost—lost to the senses I mean—nothing is lost in a chemical sense.

Q. What gas will be liberated by the action of the carbonic acid of the air on the sulphide of calcium, after the ammonia has escaped? A. I conceive, in the first place, that the carbonic acid of the atmosphere plays a very insignificant part in these chemical transformations. It is present only in 4 or 5 parts in 10,000 in the atmosphere. Undoubtedly the transformation which you ask about would result in the decomposition of the sulphide of calcium, with the formation of calcic carbonate and the evolution of hydric sulphide.

Q. To what agent do you attribute the coloring of the lead test paper you exposed to the air outside of the purifying house? A. Sulphide of ammonium. I do not conceive it possible that hydric sulphide as such should exist in an atmosphere abounding in free ammonia. The two substances will combine to form ammonic sulphide.

Q. You regard Knapp's technology as good authority? A. Up to the time of its publication, the publication in 1855, the second edition.

Q. In Vol. I., Part 2d, of the London edition of 1855, at page 610, he remarks, as follows: "The mechanical retention of the ammonia is one of the chief causes of the intolerable stench which gas lime evolves when exposed to the air. Sulphuret of calcium evolves sulphuretted hydrogen slowly when decomposed by the carbonic acid of the atmosphere; but if ammonia be not present, part is composed of hyposulphite, which has no smell. In the latter case, however, carbonic acid is rapidly absorbed by the ammonia, and the neutral decomposition then ensues between the sulphuret

of calcium and carbonate of ammonia, producing carbonate of lime and sulphide of ammonium, which escapes with its characteristic odor. So great is the nuisance produced by the effluvia from gas lime, that numerous plans have been at different times suggested for its prevention." Do you agree with his views, as there expressed? A. The passage in question rests, as I conceive, upon a false hypothesis, viz.; that it is the carbonic acid of the atmosphere which is the efficient and primary cause of the decomposition and chemical transformation of the effete lime. I cannot conceive that this theory is consistent with facts. The immediate and rapid elevation of the temperature which is perceived upon the exposure of the mass to the atmosphere, is to be accounted for, as I conceive, by no other hypothesis than that which is connected with the action of the atmospheric oxygen. It is an assertion which does not correspond with my own observation and long familiarity with gas yards, that the peculiarly offensive smell of the gas lime is chiefly connected with the evolution of the ammoniacal products. I assume that the salts present in the mass, which are chiefly active in the primary oxidation and the evolution of ammonia are the sulphide of ammonium and the sulphide of calcium, which may, if you please, be considered as united in a double sulphuretted salt. It is perfectly rational chemistry to assume that these salts react with a given number of atoms of atmospheric oxygen, with the evolution of free ammonia and the production of sulphite of lime, for example, or hyposulphite of lime, both of which are inoffensive subetances. I differ with great diffidence and hesitation from so high an authority as Knapp's Technology, but it is a matter of chemical opinion, and one chemist has as much right to his opinion in such matters as another.

Q. Do you regard Samuel Clegg as a competent gas authority? A. I do. He is one of the standard authors. The chemistry of Clegg's book is attributed to Frankland, who is certainly one of the best chemical authorities in gas matters.

Q. In his work on the manufacture of coal gas, fifth London edition, at page 187, he says, "Foul lime as it is removed from the purifier consists of an admixture of several salts. Those only that need to be practically considered are the carbonate and hydro-sulphate of lime and the hydro-sulphate of ammonia which constitute an important part of the total bulk. The analysis of these principle compounds show that more than one-half the mass consists of carbonate of lime, nearly one-quarter of hydro-sulphate of lime, about one-fifth is hydrate of lime unacted on, and the residue contains the cyanogen salts and the silicious and other impurities of the limestone with the variable proportion of hydro-sulphate of ammonia retained in the mass mechanically. With such a mixture it is not surprising that the offensive odor is emitted on exposure to the atmosphere; for, in the first place, the hydro-sulphate of ammonia must pass into the air by a simple process of diffusion, whilst the hydro-sulphate of lime being acted on by the carbonic acid of the atmosphere, will give rise to the formation of carbonate of lime, and a copious evolution of sulphuretted hydrogen-gas. It is to the prevention of this evolution of sulphuretted hydrogen that the process for purification by oxide of iron owes its chief recommendation; for the affinity of oxide of iron for sulphuretted hydrogen is greater than for carbonic acid. Hence the sulphuret of iron when removed from the purifiers and exposed to the air emits no odor whilst the sulphuret of lime is readily decomposed, and produces an abominable smell." To what extent, if any, do you differ from those views? A. I am perfectly familiar with the passage which is quoted. Have often read it. Some of its positions I accept, but in answer to the question would refer to the answer which has just been submitted to the next previous question. Inasmuch as I take a fundamentally different view of the nature of the chemical transformations, I consider the transformations due to atmospheric oxidation, and not to carbonic acid, and may be wrong in that opinion, but having embraced and entertained that opinion, after mature consideration, I shall adhere to it until drawn from it by experimental testimony? I have no partiality for one theory or hypothesis in this matter more than another, but seek to adopt that explanation of facts which is most rational and consists best with all the phenomena concerned. I don't mean to be understood as excluding by any means the action of carbonic acid in such action, but I do not consider it the primary and leading action; on the contrary, as already repeatedly expressed, that the action has its origin in the atmospheric oxygen. In support of this opinion I would submit the following chemical equations.

$$N.H^4S + CaS + O^4 = NH^3,HO + CaO,S^2O^2$$

Sulphide of ammonium. Sulph. of calc'm. Oxygen. Ammonia. Hyposulphite of lime.

$$NH^4S + CaS + O^7 = NH^3,HO + 2(CaO,SO^2)$$

Sulphide of amm'm. Sulph. of calc. Oxygen. Ammonia. Sulphite of lime.

Q. Subject to these modiffcations, you assent to his views—do you not? A. Why no, I consider the two views irreconcilable,—they are fundamentally different—totally different hypotheses; one commences with carbonic acid, and the other commences with atmospheric oxygen and carbonic acid; in other words you have not the same factors, and you cannot have the same products; and therefore, the two views are irreconciable

Q. In Dingler, vol. 125, page 159, taken from Dr. Ure, in speaking of the general malaria of London in 1850, in reference to the injurious influence of the gas lime on the health of the people, says, that "in building up a part of London named Pimlico, gas lime was used for filling up the swampy ground. During the month of October, 1849, five men descended into the sewer in Kenilworth street, for repairing, where they suddenly died. The corpses had a bronze-blue colour, especially on the mouth, neck and heart. The sewer itself was 418 feet long; four feet high, and 2½ feet wide; and was constructed out of bricks. The southern end of this canal was shut up on account of only three houses standing there; but the northern end communicated with other sewers. There could only be drain waters entering the canal, as no other but those three houses had a communication with it. On the bottom of this sewer was found, on investigation, a greenish earthy material one foot in depth, covered with a similarly colored stinking fluid. A similar mass was found outside on the top of the canal. There was therefore, no doubt, but poisonous gases were generated from the gas lime. Ure, and several other chemists, analysed the solid as well as the fluid contents of this canal, with the following results:

"The solid mas was recognized as gas lime saturated by hydro sulphuric acid, sulphide of ammonium, and cyanogen compounds. In contact with the carbonic acid of the atmospheric air, those obnoxious gases were liberated and absorbed by the rain water. This explains why the above mentioned green colored stinking fluid could contain those poisonous gases.

"From one of the London gas works spent lime was taken and washed out with water; the fluid was then analysed. One gallon of it contained 1,911 grains soluble matter, viz: 1,330 gr. lime, 301 gr. ammonia, and 280 gr. sulphur. One gallon treated with hydro chloric acid generated nearly three (3) gallons of dangerous gases and 3½ gallons of this fluid yielded 1 ounce of Prussian blue, which represents 25 ounces of hydrocyanic acid of the strength required by the London Pharmacopeia, a quantity sufficient to kill fifty persons. By this one may judge how detrimental to the health of the neighborhood the accumulation of gas lime must be." Do you consider the authority good? A. Ure is a good authority; I should infer from the reading of this evidence that these men had been killed by exhalations which undoubtedly had their origin in the gas lime under these exceptional conditions, and which contained hydrocyanic acid or prussic acid. The evidence, as far as stated, corresponds with that mode of poisoning. I would remark in this connection that the sulphocyanide of ammonium is a well-recognized product of gas distillation; that it exists in all gas, probably; the illuminating gas I mean, as it is distributed to the houses; and it is the opinion of good gas chemists that it is the chief source of the sulphur which escapes in the combustion of the gas which has been otherwise purified from free sulphur. In this connection I would also say that the most thoroughly purified illuminating gas, it matters not by what method it may have been purified, is itself, in the sense which is here employed, a poison. An atmosphere containing a considerable portion of free illuminating gas would be destructive of health, and that numerous cases are on record of life destroyed by persons who, having retired have carelessly blown out their light instead of extinguishing it. And though the atmosphere could not, in the course of time, intervening between the night and the morning, have contained more than ten per cent. at the outside, of its volume of these gases. That the offensive odor which illuminating gas retains is to be regarded as a blessing and not as a curse, that it is the one sufficient warning to instruct an unscientific and incautious person of the existence of danger. That the suffocation of men who have descended into sewers or gaswells, is a fact of abundant record. Numerous instances have occurred in this country, some within my own personal knowledge, of men engaged in gas works descending into what is called the gaswell to look after the attachments leading to the main distribution, having been suffocated and lost their lives, not in consequence of any specific poisonous property that attaches to the illuminating gas as such, but that they were drowned in the irrespirable gases. That they are irrespirable in the sense that they are insufficient of themselves, or even in the presence of atmospheric air, to sustain life, acting by exclusion of the atmospheric oxygen, and this is wholly irrespective of the question as to whether there may or may not be in the carburetted hydrogen gases portions of other substances, which are specifically poisonous in the sense that term is used by toxicologists.

Q. In the same sense, are not the gases evolved from spent lime when exposed to the air irrespirable? A. They are clearly.

Q. In your opinion, is sulphuretted hydrogen decomposed in the air? A. Yes, sir; decomposed or recombined. I would say, it may be decomposed or recombined with other substances in the air. Sulphuretted hydrogen, or compounds of that gas with ammonia, are always present in the atmosphere of cities. A fact familiar to every housekeeper is that silver is speedily blackened by exposure to the atmosphere of our houses in towns, which is attributable to the presence of sulphur compounds in the atmosphere.

Q. Do you regard Berzelius as a standard authority on the subject of gases? A. I do.

Q. In the fifth edition of his work, vol. 1, page 849, Berzelius says that sulphuretted hydrogen is not decomposed by dry oxygen? A. I did not say it was; I did not make any such assertion as that. You asked me if sulphuretted hydrogen might not be decomposed in the air. I said yes; but the atmosphere is not dry oxygen.

Q. How do you suppose sulphuretted hydrogen to decompose in the air? A. There are various transformations of sulphuretted hydrogen in the air; it may be combined directly with ammonia or the carbonate of ammonia, both of which are liable to be present in the atmosphere from natural causes, in which case it would exist as sulphide of ammonium. In the presence watery vapor it may be transformed by oxidation. I wish to add to that another point, which is a fact familiar to every chemist, that the solution of sulphuretted hydrogen in water cannot be kept for any length of time because of the transformation or decomposition of that compound, accompanied by the precipitation of free sulphur, due to the combination of the hydrogen of the sulphur compound with the free oxygen dissolved in the water. The same transformation of sulpho hydric acid occurs in the atmosphere, and from the same cause, viz.: the oxidation of its hydrogen in moist air.

Q. Is there much watery vapor in the atmosphere during the cold season? A. The atmosphere is never without watery vapor.

Q. Is there as much? A. There is less during the dry cold weather than during moist warm weather, of course.

Q. Berzelius states, in the same volume, same page, that a single cubic inch of sulphuretted hydrogen is sufficient to make its presence apparent in all parts of a room by its disagreeable odor. Do you doubt this? A. Is the size of the room mentioned?

Q. In the case of a large room? A. Terms are comparative. If by a large room he means a room of this size, I say yes; but if he means the Academy of Music, I say no.

Q. This sulphuretted hydrogen withstands decomposition for a certain length of time in the air? A. Yes, sir; it is wafted upon the winds a certain distance from sulphur springs, but not to a very great distance. I spoke of those springs near Rome, and in the neighborhood of Avon and Sharon.

Q. Same vol., page 852, Berzelius says: "Thenard, referring to the poisonous character of sulphuretted hydrogen, remarks that a bird died in air containing 1-1500th part of its volume of sulphuretted hydrogen, and a dog in air containing 1-800th part." Do you agree with the statement? A. Yes, sir; I do not admit the presence of free sulphuretted hydrogen in atmosphere containing ammonia. That is a point of difference between my friend Dr. Chandler and myself.

Q. Your statement as to the offensiveness of effete lime exposed to the air, would apply to the process as conducted by the Metropolitan Gas Works, would it not? A. It would.

Q. Are you aware of any special precautions being employed at those works, to prevent the spent lime from becoming a nuisance or offensive? A. Beyond the exercise of a reasonable vigilance, and cleanliness about their purifying house—in this respect I find the works in commendable order—I found no special precautions.

Q. There are none of the special precautions to which you refer?

A. No, sir; there are not.

Q. Could not the Metropolitan Gas Company with very little trouble or expense, abate, or effectually prevent this nuisance in the way described by you, or by some other method? A. The offence complained of in the case of the Metropolitan Company, may certainly be abated at no very large expenditure of time or money; it will take some time, and take some money, and without new causes of offence, or new causes of unhealthiness. Certainly I should like to add to that answer, that in my judgment, they are entitled to a reasonable consideration in the time requisite for the effect of such changes; they of course, involve new constructions, and some expense.

Q. Is from the 15th July last, to the present time, a reasonable time to make the changes? A. If the changes in question had been contemplated in July, they certainly could have been effected by this time; my familiarity with the case, however, dates from the 5th of Feb'y, I think. If they had entered upon such a process of reconstruction in July, they should have had it in efficient action long ere this; I cannot say, however, of my own knowledge, that in the interim,

they have not taken some precautions—that is more than I know.

Q. As an expert, would you recommend improvement in the ventilating process now employed there—would you not? A. They have none.

Q. Would you recommend the introduction of the ventilatihg process? A. I should recommend the introduction of a well considered plan of ventilation, as the only efficient and sufficient cure for the evils complained of.

Q. You have recently visited the works? A. I have.

Q Have you seen there any preparations for the introduction of such an improvement? A. Not to my knowledge; my attention was not called to any such; the remark was made that they were about moving certain masses of coal and buildings, with a view to new constructions.

Q. For what object? A. I did not inquire; it appears that the Company have four extra purifiers—had at the commencement of this year.

Q. Could they not adopt the iron process in a much less period of time than that required for the ventilating improvement you mention· A. They have two sets of four boxes each at the present time, two of the older and two of the newer form of construction. There is not room in their existing houses for the iron process There is not sufficient space, as I conceive, for the display of the mass of effete iron for reoxidation. It r quires a very considerably enlarged area over the ordinary lime process to spread out the mass of spent iron, and revivify it. And that space does not exist in the present buildings. I shonld think the time consumed in suitable preparations for the iron process would not vary much from which would be required for ventillation. I said I thought three months ought to do it.

Q. Could not they introduce the oxide of iron there, so it should be used to purify the gas. Could they not in a very short time? A. As I understand your question, it would contemplate the use of successive doses of iron material, as they now use successvio doses of lime material·

Q. Could they not arrange to do that in a very short space of time? A. I think that that ot course would be met with olmost unsurmountable difficulties, for this reason, that the iron process does not work so well in the first action as in the second, third and fifth. It improves to a certain point in quality, and therefore you would always be at the worst point if you were always to renew it

Q. Suppose they had proper facilities for revivifica tion, would there be any difficulty in introducing the iron process at once? A. None occur to me.

Q. What is the difficulty of using the space which they now occupy for their refuse lime for the purpose of revivification of their iron? A. I am not sufficiently familiar with the economy of the works exactly to say what the proper answer answer to that inquiry is.

Q. Is any peculiar machinery or buildings, or anything ofthat kind needed for revivification? A. Nothing but a shelter.

Q. A shed? A. Yes, sir; you want a somewhat steady temperature. That is, you would not wish it exposed to the outer air.

Q. I believe nothing has been said of the kind of lime used by yourself. A. In America we always use oyster shell lime.

Q. What is the advantage of oyster shell lime? A. It is an exceedingly fine form of lime. Its subdivisions or laminations render it peculiarly favorable.

Q. Is there any necessity of that shell lime being fresh.? A. It must not have been carbonated; it must be fresh hydrate of lime. Practically it is used as fast as it is burned.

Q. Is not the oyster shell lime used because it is cheaper? A I don't think that is a primary consideration. No, it is not cheaper. For instance, in Portland it is not cheaper than stone lime.

Q. Is it used in Portland? A. I can't say it is; but I say in a lime country you can get stone lime cheaper.

Q. Where you can get stone lime, do they use stone lime or shell lime? A. I think that question would be decided by the relative economy.

Q. Are there not a great many portions of the world where they cannot get shell lime? A. In England they use stone lime almost exclusively.

Q. What period of time will 100 feet of gas in its consumption pass through an ordinary burner? A. It depends upon the size of the burner.

Q Fix the size of the burner and fix the time? A. In a burner using 5 cubic feet of course it would be 20 hours.

Q. I want to know what is the ordinary burner used in the house, how much? A. Their name is legion, if you mean the volume of gas they consume.

Q. Yes, sir. A. The volume of gas consumed would average from 4 to five feet.

Q. Therefore, it would take 20 hours on an average to burn 100 cubic feet of gas? A. Yes, sir.

Q. With 50 grains of sulphur in that 100 cubic feet of gas, is it your opinion that there is any injury to health from that amount of sulphur, in that amount of gas consumed? A. I never said there was any injury to health. It is a nuisance. The combustion in the house of gas containing sulphur occasions irritation to the eyes.

Q. Is gas purified by dry lime ever free from naphthaline? A. I think that is dependent on the temperature at which gas is made, and the variety of the coal ftom which it is made. Gas that is made from poor coals is never free from naphthaline. As you approach the limits of the law in England, in the matter of elimination, you increase the risk of precipitating the naphthaline which is held in solution in ordinary gas in virtue of the presence of the richer illuminating hydrocarbons; hence, gas which is made from poor coals is always more likely to let fall its naphthaline, and to occasion trouble to the gas engineer and to consumers, from the obstruction of the pipes by this crystalline compound, especially in cold weather, than gas which is made from rich coals.

Q. As the business of manufacturing gas in this city is conducted, is not naphthaline present? A. I conceive that naphthaline is almost uniformly present in coal gas, and that it is a very important constituent of coal gas. It being a powerful illuminator, the objection to it being as I stated, that when from false views of economy, or other reasons, poor coal is employed, the naphthaline which ought to be sustained in the gas in the permanent form is precipated, and the loss of the naphthaline is a loss to the consumer.

Q. Is there any sanitary objection to its presence? A. I don't think there is. It is rather an agreeable thing to me to smell naphthaline as a perfume.

Q. Is there probably more than a trace of phenol in gas as it reaches the purifier? A. I have never examined that question personally.

Q. What is your opinion? A. I certainly should not expect the presence of any large quantity of phenol in the gas, though there is reason to believe it may be there in a sensible quantity.

Q. What becomes of the greater part of the phenol produced by the decomposition of coal? A. It is found in the coal tar, and associated also with the tarry portion of the lime, or other agents of purification, in the purifying boxes. I brought to this room last week, but I am not certain that it was exhibited, a bottle containing lime richly charged with tar from one of the purifying boxes from the Manhattan Company, in proof that the tar is condensed in the purifiers, and Dr. Bowditch says, you can always obtain from the best purified gas in London a portion of tar by methods which he gives, and I add that, with the tar there is a legitimate portion of phenol. Phenol is the creosote of coal tar.

Q. What will become of the minute trace of phenol remaining in the gas after purification, after the gas is burned? A. I suppose it must be exhaled among the effete products of combustion. I suppose it goes to watery vapor.

Q. Is it not quite probable that it will be burned with the gas? A. It is certainly possible.

Q. Is it not a good illuminating agent? A. It is.

Q. Is it probable that any possible nuisance could result from its presence in ordinary practice? A. No.

Q. Have you any reason for believing the oxide of iron is less efficacious in removing the phenol than the dry lime? A. I have no experimental reason.

Q. Have yon any other? A. I have an impression that the phenol would be more apt to rest with the lime than with the iron. Still that is an impression not founded upon the result of any experiments, and I do not attach any value to it.

Q. Is there any chemical reason supporting such an impression? A. It is rather hard to analyze one's convictions on anything of that sort. An impression rests in my mind upon the general knowledge of the subject. There is a compound of phenol with lime. I don't know that there is any with iron. There is just where the point of departure on the impression arises. Chemistry is an experimental science pre-eminently, and experiment does not always substantiate the theoretical exceptions of chemists; sometimes it does more.

Q. Is not this substance considered the best antiseptic found in gas manufactories? A. I so stated in my direct examination, and gave examples.

Q. And it is used in such practice? A. Yes, sir, in the practice of antiseptics, and in the preservation of ments, and so on.

Q. Is it not probable that the carcasses you mentioned in your direct testimony as not likely to undergo decay in the purifying houses, would be preserved by phenol and not by sulphuretted hydrogen and not by sulphide of ammonium? A. I intended in that testimony to convey the distinct impression that it was the phenol that would act as the antiseptic generally, and never the sulphuretted hydrogen.

Q. Is there anything in phenol or its properties which renders the question whether more or less of it would pass by the lime or iron process of any importance to this investigation? A. No, I think not.

Q. Then the introduction of the question of phenol you would leave out entirely? A. I think it is a very interesting question, but I don't think the public health is prejudiced in the least by it.

Q. Is the phenol given out to the atmosphere from the effete lime, in any way so as to have a practicable or perceptible effect upon the atmosphere? A. The proper answer to that question would involve experimental data of which I am not possessed.

Q. You have no knowledge that it is so given out? A. No personal knowledge.

Q. Have you any theoretical knowledge? A. I think that in the decomposition of the lime it would be given out.

Q. So as to have any practicable or perceptible effect on the atmosphere? A. I revert to my testimony in regard to the effect upon carcasses.

Adjourned to Thursday, the 18th instant, at one o'clock.

THURSDAY, FEB. 18, 1869.

Professor *Benjamin Silliman*, recalled. Examination resumed.

Q Is not acetylene burned or destroyed in the combustion of the gas? A. Not always; on the contrary, acetylene is produced in the combustion of gas, if that combustion is in any considerable degree impaired. For example, in the ordinary wire gauze gas stoves, which are so frequently used in warming small apartments and in cooking, acetylene is produced in very notable quantities, as has been proved long since by Berthelot; and there is reason to believe that acetylene is also produced under other conditions than those of the wire gauze gas stove; when the supply of oxygen is imperfect or from any reason, as from the presence of carbonic acid; perhaps it may be from an insufficient supply of oxygen gas. This fact has been very lately brought to our notice afresh by a recent Memoir of Berthelot, which is published in the proceedings of the "Paris Chemical Society." The title is now changed to the "*Bulletin de la Societe Chimique.*"

Q. As gas is ordinarily consumed, is acetylene produced in any considerable quantity? A. The question is answered in a reply to your previous question. Berthelot, in the last memoir above referred to, affirms that in the ordinary bat'swing burner as ordinarily used, acetylene may be detected. I have not verified this statement myself, but Berthelot is such an excellent authority that I would not question his accuracy.

Q In Dingler, vol. 165, p. 149, Berthelot states that gas contains but a few ten-thousandths of acetylene. Do you agree with that statement? A. How recent a a number of Dingler is that?

Q. 1862. This is a copy of Berthelot's original article. A. I accept whatever statement Berthelot makes, as an authority.

Q. Do you regard its removal from gas a matter of any importance in the quantity in which it generally exists? A. I regard its presence in gas as very undesirable, and that whatever tends to its production should be carefully avoided, for I believe it is fully in proof, that the presence of small quantities of acetylene in the atmosphere where gas is burned, and resulting either from the distribution or combustion of gas, is proved to be particularly prejudicial to health and comfort, and that it induces headache and sickness and *malaise*, which is complained of by those who inhabit rooms which are warmed by unventilated gas stoves. It is one efficient cause of *malaise*.

Q Do you regard it as any more injurious than the smell which arises from the burning of kerosene? A. I am not aware that the smell which arises from the burning of kerosene is injurious. It is disagreeable and offensive. I never experienced any ill effect from these odors. Nobody of choice disseminates ill odors of any kind in apartments.

Q. Have you any good reason for supposing acetylene to be any more injurious than the odor just spoken of? A. Yes, sir. I think that is clearly in proof that it is not merely an ill odor, but a poison acting on the nervous system. I do not know that any one asserts that the odor from burning petroleum is a poison.

Q. Your objection applies more particularly to cases where gas is applied to stoves? A. The production of acetylene under those circumstances is far more notable—more abundant.

Q. Does it not appear in gas purified by lime as well as by iron? A. I dare say it does; I have detected it in gas purified by lime.

Q. Have you not detected it in gas purified by iron? A. I never have. I have never had the opportunity; I have never seen that process in operation, except at the New York Gas Works, and under circumstances not favorable to experiments. I simply consider it the duty of gas companies to render gas as free as possible from every source of objection that can properly be raised against it as an article of consumption in houses. It is unquestionable that in the United States we consume gas in our domestic life far more commonly than is done in England. It is still a comparatively rare circumstance in England that gas is used in houses, and the prejudice against it in London when I was there, which was several years ago, was very strong, and chiefly, as I believe, because they had been so ill-treated by the metropolitan companies.

Q. Do you mean to state that the dry-lime process is the only one which removes carbonic acid from the gas? A. No; the wet-lime process removes carbonic acid very perfectly, and the Laming process may remove carbonic acid also, perfectly, if it is properly conducted; but I conceive that no iron process which is entirely without the presence of lime will purify gas completely of carbonic acid.

Q. Would not Laming's iron process as applied in London effectually remove the carbonic acid? A. I judge from my readings only, for I have never had an opportunity of observing it personally, that Laming's process is capable when properly conducted of depriving the gas of its carbonic acid, but that, in fact, as ordinarily conducted, it does not.

Q. I limited it to the London application. A. I speak of it exclusively as applied in London. My inference is founded upon my readings of the discussions of that subject in the English journals. I know that the complaint is general in London of the low quality of the gas as respects illuminating power, and that the statement is constantly reiterated, that the gas does contain a notable portion of carbonic acid. It is true that the Metropolis Gas Act requires only 14 candle power, which we should consider very low.

☞ *For continuation see Supplement.*

Artificial Light and the Subject of Ventilation.

[From "The Manufacturer and Builder" for February.]

It has long been settled that the leading cause of the frequently unhealthy condition of air in dwelling-houses, even where the ventilation, or, rather, the facility for it, is ordinarily good, has been the over-abundant generation of carbonic acid gas. To the sources of this generation little attention has been paid in this country, though in Europe, and in Germany particularly, it has been made the subject of repeated experiment. The learned German savant, Pettenkofer, has, in fact, expended considerable time in minute investigation of the extent to which the air in dwelling-houses may become burdened with carbonic acid gas, and has demonstrated that its quantity may be taken as an indicator of the impurity of the atmosphere, as impurities produced by organic vapor are nearly always proportional to its increase. Again, the increase of this gas indicates with tolerable exactness how many times a certain quantity of air has been subjected to the respiratory processes of any number of individuals.

One point of immediate value has been developed in the course of these investigations. It is, that artificial light exerts an injurious influence on the air in dwelling-houses to a greater extent than is generally supposed; and the brighter the illumination—that is, the more numerous the gas-burners—the worse the air in any given apartment, which suggests the fact, that the proportion of gas-burners to the size of the room, consistent of course with a proper amount of light, is not only economical in a pecuniary sense, but healthful and necessary.

It is an obvious fact that, in gas-illumination, there must be a considerable consumption of oxygen and a balancing generation of carbonic acid. Dumas long since stated the fact authoritatively, but ventured no guess as to the value the factor, carbonic acid, might assume in the study of scientific ventilation.

It would appear, according to the theory of combustion, as if the quantity of carbonic acid gas, and that of the gaseous products of imperfect combustion, ought to be in inverse proportion the one to the other. This would be so if the combustion were perfect; but, unfortunately, in ordinary illumination, perfect combustion is the exception. Practically, therefore, products of perfect and imperfect combustion are in a nearly invariable proportion the one to the other in ordinary illumination; and to its processes the theory of the results of perfect combustion can not be applied. Practically, too, it follows that the quantity of carbonic acid generated in ordinary illumination is in about the same proportion to the material consumed as are the quantities of carbureted hydrogen and oxide of carbon. The law developed by Pettenkofer relative to the proportion of carbonic acid gas generated by the respiratory processes being an accurate measure of the impurity of the air, applies with equal force to the impurities generated by gas-burners; and, as the increase of the gas indicates the increase of other impurities in cases where they are generated by respiration, in like manner the carbonic acid in the air of a lighted apartment is a gauge of the impurity thereof.

Experiments in relation to this subject have been made, in Germany, by Dr. Zock, an able scientific man, who has also effected a determination of the question as between gas, petroleum and rape-seed oil.

Consumption of material, time, and intensity of light were all taken into consideration; and a room of the capacity of 2540 cubic feet, with two large windows—the material of the building being good dry sandstone—was used for the purpose.

A common soap-stone burner was used for the gas-illumination—the gas being a coal product of good quality. The consumption was five cubic feet per hour, the illumination being equal to ten and a half normal flames, reckoning the normal flame at that of one stearine candle weighing a quarter of a pound. The petroleum illumination was effected by means of a common lamp with burner. The consumption was equal to 231 grains per hour of rectified oil, of the specific gravity of 0.805. The illumination was equal to three and a half normal flames. For rape-seed oil, a moderator-lamp with round burner was used, the consumption being equal to 470 grains an hour, with a light equal to four and a half normal flames.

Bunsen's photometer was used for photometric measurements; and, for the determination of the carbonic acid, a solution of baryta and oxalic acid was used, which is Pettenkofer's method—the test being applied before the gas was lighted, and after it had burned the specified time, and the difference being noted.

The experiments were ten in number, ranging from forty-seven minutes to four hours, with ten and a half normal flames. The following schedule notes the results:

Burning Time.	Gas Consumption in Cubic Feet.	Carbonic Acid of the Atmosphere, Per Thousand.		Increase of Carbonic Acid.
		Before Combust'n.	After Combust'n.	
47 min.	4	0.553	1.447	0.894
47 "	4	0.655	1.466	0.811
48 "	4	0.543	1.405	0.862
48 "	4	0.560	1.443	0 883
48 "	4	0.555	1 395	0.840
49 "	4	0.736	1.570	0.834
1 h. 40 "	8	0.334	2.249	1.915
1 h. 55 "	8	0.512	2.343	1.831
1 h. 56 "	8	0.636	2.315	1.679
4 h.	20	0.647	2 954	2.307

From this table it is worth observing that the quantity of carbonic acid gas in the air of the room, with a single gas flame of ordinary brightness, may rise to the proportion of three parts to the thousand—a quantity supposed to be possible only in hospitals, prisons, and garrisons; and what shall be said when it is considered that, in an ordinary parlor, as many as three burners are kept constantly lighted for five and six hours, and with an inferior quality of gas at that?

In the case of the petroleum, the lighting effect was only equal to three and a half normal flames, and the maximum of carbonic acid was 1.577. Subjoined is the tabulated result of six experiments; time ranging from one to three hours:

Burning Time.	Kerosene Consumption, in Grains.	Carbonic Acid of the Atmosphere, Per Thousand.		Increase of Carbonic Acid.
		Before Combust'n.	After Combust'n.	
1 h.	235.33	0.593	1.072	0.497
1 h.	235.33	0 550	0.975	0.425
2 h.	470.61	0.786	1.438	0.652
2 h.	470.61	0.675	1.440	0.765
3 h.	795.15	0.606	1.441	0.865
4 h.	944.31	0.697	1.577	0.880

In the case of the rape-seed oil, only four experiments, ranging respectively one, two, three, and four hours, were made. The lighting effect was four and a half normal flames; a moderator-lamp with an Argand burner being used. The tabulated results are as follows:

Burning Time.	Rape-seed Oil Consumption, in Grains.	Carbonic Acid of the Atmosphere, Per Thousand.		Increase of Carbonic Acid.
		Before Combust'n.	After Combust'n.	
1 h.	416 51	0.908	1.224	0.336
2 h.	941.23	0.513	1.162	0.649
3 h.	1296.12	0.623	1.367	0.744
4 h.	1820 74	0.769	1.537	0 768

These results involve important conclusions; first of which is the conclusion that petroleum yields more carbonic acid gas than street gas, and street gas more than oil. The experimenter also observed that, in petroleum illumination, the atmosphere was greatly vitiated at 1.779 per thousand; while with the use of gas the vitiation was less; and with that of rape seed oil not perceivable at all.

The conclusion, in so far as it affects gas illumination, is highly important; though, in its use, considerable of the discomfort is no doubt due to radient heat, also an effect of such a method of illumination. Briquet, an eminent physicist, has found that a gas burner consuming 4.87 cubic feet per hour, heats 1.74 cubic yards of air from 32 to 212 degrees Fahrenheit; but to this can not be due the impediment to breathing the dry heat in the throat, the tickling in the larnyx and the dry, fatiguing cough, to which individuals are liable when compelled to remain for a length of time in brilliantly-lighted rooms. That an atmosphere impregnated with three parts per thousand of carbonic acid gas, in consequence of artificial illumination, can not be healthful, is certainly obvious, from the application of the law of Pettenkofer. The matter is worth study and experiment in this country, with a view to a full practical solution of the difficulty.

Chemical Engineering.

By Prof. Henry Wurtz.

[*From the new Journal; "The Manufacturer and Builder," Revised by the Writer.*]

The time has been, and is even now slowly lapsing into the darkness of the past, when men who delve for knowledge beneath the surface of things were pitied or scorned as poetic dreamers, or as grown-up children, by the mass of mankind; and especially by that class who call themselves "practical men." But now many of these children, many even who have grown up in the chase of butterflies and the like, are recognized and honored as benefactors of the race. At present it is with another class of the children of science that we have to do. The time has almost come when few will sneer at the statement that more is to be learned, of a strictly *practical* kind, in relation to the laws governing the strength and durability of materials—an accurate understanding of which is so essential to the weal of man—from the investigations of scientists, than from all the experiments with bricks and mortar since the building of the Tower of Babel.

We may reasonably hope that the time is near at hand when even that powerful word-weapon of the practical man, the "*Cui bono?*" will cease to tyrannize over the world at large, or discourage the seeker after the hidden truths of nature.

It may in any case be assumed that there exists, among the readers of this periodical, an important and leading class of the community, now rapidly growing in numbers, who will feel no surprise at the assertion that the path of practical discovery, which is to lead mankind to the mastery and the intelligent use of *materials*, lies through the chemical laboratory. The theme is one on which a treatise of some magnitude might even now be written, and which soon will rank as a separate specialty. I believe that the practical engineer who has passed through a thorough course of laboratory training will soon hereafter find himself, *cæteris paribus*, ranking high above those who have merely traveled in the old beaten paths. Still, however, we must admit the subject is yet very much in embryo. As in mechanism the realization of new combinations and inventions, and even the introduction of new materials or tools, requires continued invention and construction of new *subsidiary* tools and machines for combining, handling, and manipulating these, so in science all progress must likewise be gradual and cumulative. All human experience proves, nevertheless, that the law once discovered, its practical application is but a matter of time, and nowadays frequently of a very short time. The shrewd engineer will therefore prepare himself for what is to come, by maintaining a thorough familiarity with those discoveries made in the laboratory that bear in any way upon the practice of his profession.

In an article like this, space will admit only of a few brief citations of the more prominent illustrations of the facts that point to the near establishment of the new specialty, for which the name "Chemical Engineering" is proposed. In future numbers the subject will probably be resumed more in detail.

The mere chemical composition and analysis of materials is in itself often of minor importance, and only of subsidiary value. But late discoveries of scientists regarding the molecular structure and *texture* of materials, and the changes which these undergo, promise results of direct importance to the engineer and the architect.

The facts that axles, rails, and springs give way, bridges break down, buildings fall, and boilers and cannon burst, and that, too, often without any assignable fault in their original construction, belong to a range of phenomena now calling for the active investigation of chemists, and results of the utmost import are already foreshadowed. In some of these cases, it has been long known that certain changes are found to have taken place in the internal texture of the fractured material. Until recently, it has been generally

supposed that these changes were of a merely mechanical nature. At all events, few persons have referred these results to causes of a strictly chemical character.

Since the experiments of WADE and RODMAN, it has been obvious to chemists that the bursting of cannon is most frequently due to the corrosion, both superficially and in its inmost substance, even to the extent of a complete honeycombing (especially in the neighborhood of the vent) of the metal; by the injection into its pores of the vapors of sulphur and sulphide of potassium.

Chemists have long known that pure distilled water will dissolve ferrous hydrate, and in the presence of free oxygen will quickly take up metallic iron into this form of solution. Hence, in a steam boiler, such portions of the internal surfaces as are subject to the condensation upon them of distilled water from the steam, in an atmosphere which always contains free oxygen that had been dissolved in the water, and frequently under heat and pressure, must be both corroded superficially and disintegrated internally. In this we have the cause of many of our most fearful disasters.

How many lives have been lost by the breaking of axles, springs, rails, etc., which might have been saved, had we known how to protect these completely from the corroding action of the oxygen of the air, introduced in aqueous solution into their pores and flaws, none can tell. The new experiment of steel rails, in a climate like ours, whose intense cold is known to destroy all the viscosity of steel and leave only its brittleness, is contemplated with foreboding. This latter case leads to the suggestion that no question requires the attention of the investigator more than those connected with the different kinds of consistence of matter, the influence of various agents in modifying the same, and the modes of producing and conserving any desired form of consistence. GRAHAM has generalized all consistence under two heads: the crystalloid and colloid. It seems clear to me that to these must be added the viscous or viscoid consistence, if not still other distinct species.

The effects of natural and other chemical agents upon the various forms of vulcanized rubber and compounds thereof now in use, are undergoing investigation by one of the most eminent of our American chemists, with results of the highest novelty and importance, in due time to be laid before the public.

Another great field for the chemical engineer—to which much attention has been already given, but which has by no means begun to yield its full fruit—is in the preservation from decay, from fire, and other destructive agencies, of such substances as stone, wood, and other materials used in building, and in the construction of vehicles. It is clear that iron as a material for these purposes, is continually disappointing the sanguine expectations of those who do not understand well its inherent defects; and I believe the time will soon come when wood, so prepared chemically as to be incombustible, indestructible, and a perfect nonconductor of heat, will be the almost universal material used in the construction of buildings and vehicles, except of course the machinery of the latter.

Lime Juice.—Mr. L. Rose, of Leith has, it is said, solved the problem of preserving lime juice, hitherto so liable to deterioration. The details of the process, just given to the public, will be of great service, as lime juice is one of the best preventives of scurvy yet discovered. The *London Chemist and Druggist* describes the process as being the mixture with the juice of an extremely small quantity of *sulphurous acid*, its sulphites or bi-sulphites in no case exceeding one to two per cent. of the acid, which is allowed to remain in the juice for a certain period, until it has thoroughly acted on the innumerable seeds or fungus with which these juices are so fully charged, the juice being afterwards partially exposed, so that any excess of acid is thus thrown off. It speaks in the highest terms of the method, and asserts that the juice in no case loses its fine flavor or aroma, and is entirely free from the mouldy taste of the unpreserved juices. The preserving agent is in itself mechanical, and its cost is merely nominal.

Soda.—A German chemist proposes a new method for the manufacture of soda on a large scale. He takes the double chloride of aluminium and sodium, melts it, pulverizes it, and carries the powder by a blast of a fan into a retort heated to a very high temperature, into which enters at the same time a jet of superheated steam. Hydrochloric (muriatic) acid is formed, and aluminate of soda. The aluminate of soda, decomposed by carbonic acid, yields a very pure carbonate of soda, and alumina, which latter can be used over again. The hydrochloric acid is also a valuable product. The method has been much praised by the German scientific press.

Correspondence.

[Correspondents in all cases should sign their communications with their names and address in full, not necessarily for publication, but as a guarantee of good faith.—EDS.]

Valuable Information.

Messrs. Editors: Many small gas-works are so constructed that the tar from their condensers and washer runs to waste. This, besides the loss of tar, and the clogging up of drains, creates a nuisance in the vicinity of their works, which can be easily abated by connecting their drains with a small wooden tank to receive the tar. A works sending out six million feet per annum, can save in this way fifty barrels of tar which, at present prices, makes an item worth saving.

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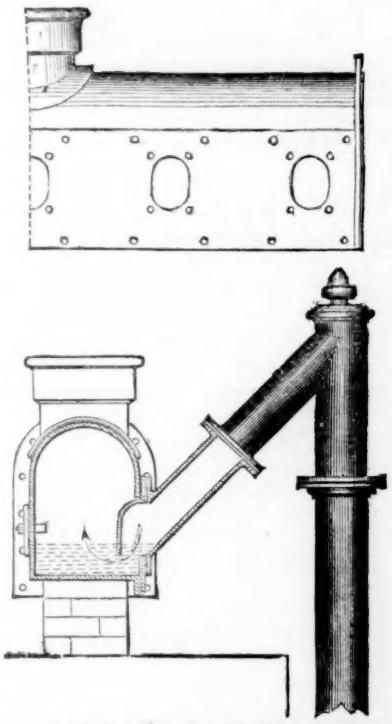

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PROFESSOR HENRY WURTZ.

[NOTE BY PROFESSOR WURTZ.—Contributions and items for which I am, as a Scientist, individually responsible, will have attached my full name or initials.—H. W.]

TUESDAY, MARCH 2, 1869.

WISHING TO MAKE this Journal an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of those subjects a pleasure, or a profession.

Subscribers would confer a favor upon us by remitting *CHECKS* or *POST OFFICE MONEY ORDERS*, as we are frequent losers where money is enclosed in letters.

☞ NEWS AGENCY.—The American News Company, 119 and 121 Nassau street, New York, are agents for this Journal. Newsdealers will please send orders to them.

CONTENTS

Novelty Portable Gas Light 257
The Bursting of Water Pipes 257
Explosion at the Rochdale (Eng.) Gas Works 257
The Gas Companies and the Board of Health 258
Artificial Light and the Subject of Ventilation 262
Chemical Engineering 263
Lime Juice 263
CORRESPONDENCE—
Valuable Information 263
Answers to Correspondents 264
EDITORIALS—
Gas-Light Companies and the Board of Health 264
Management of Gas Burners 264
Ludlow Valve Manufacturing Co 264
Oreide 264
The New York Gas Companies 264
New Publications 265
Report of the Treasurer of the Bath (Me.) Gas Company 271
Miscellanea 272

NOTICE.

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TO OUR SUBSCRIBERS AND PATRONS.

In making remittances for subscriptions, always procure a draft on New York, or a POST OFFICE MONEY ORDER, if possible. Where neither of these can be procured, send the money, but always in a REGISTERED LETTER. The registration fee has been reduced to fifteen cents, and the registration system has been found by the postal authorities to be virtually an absolute protection against losses by mail. ALL Postmasters are obliged to register letters whenever requested to do so.

Answers to Correspondents.

B., of Mass.—Anthracite coal is not used for making illuminating gas, neither will it produce coke.

H. H., of Miss.—We are not posted in the matter in question, and can only refer you to the *American Agriculturist* of this city.

E. M., of La.—The relative value of wood and bituminous coal may be stated thus: Bituminous coal 23·50° Wood, 17·50°. In common use, two cords of hard wood are considered to be equal in heat giving qualities to one ton of coal.

O. M. W., of N. Y.—The humming sounds of telegraph wires is due to their vibration by currents of air. They are, in fact, only modifications of the Æolian harp.

E. B. H., of Mich.—Compressed air can be used as the motive power for any form of steam engine in use, but the principle of condensation in low pressure engines can not obviously be applied to compressed air.

B. E. R., of Ill.—The pressure of water upon the sides of a cistrrn or pipe containing it is directly at its height. The diameter of the column has nothing to do with it.

GAS-LIGHT COMPANIES AND THE BOARD OF HEALTH.

The question of "shutting up" our gas-works, or compelling them to "remove some miles out of town," is one of great magnitude, and the fact of their being nuisances of an unbearable nature, or greatly detrimental to the public health, should be clearly and undeniably established before such extreme measures are resorted to.

The disagreeableness—or nuisance if you please—of gas-works as now conducted, and their unhealthfulness are entirely distinct propositions, and should not be confounded. What might be a nuisance to a person in one state of health would not prove unpleasant to those in another; and this is not only so in the manufacture of gas, but also in very many necessary occupations, down even to the cooking of wholesome and nutritious food. The odor which arises to the nostrils of a pedestrian as he passes some of our numerous dining-saloons during the preparation of a meal, will cause a nausea to many who would be unaffected during a visit to the purifying room of our gas-works; but this does not prove that it is prejudicial to health. We admit that the smell of gas and the odors arising from its manufacture are disagreeable to the extent of being a nuisance to a majortiy of people, but if it was proven to them that it was a specific remedy and preventive of consumption, cholera, whooping cough, and many other ills that flesh is heir to, they would not only endure it, but would seek its virtues, as they now do of the nauseating drugs that are prescribed to them. And proof is not wanting of the beneficial effects of gas and its concomitants in the above named cases, but many more. In England it is known that upon three visitations of of epidemic, residents in the immediate vicinity of gas-works escaped its ravages, while others were stricken down. There are men employed in gas-works in this city to-day who would have been in their graves from consumption, but for the benefits derived from their occupation. It has also been advised by a physician who has had much experience with cholera and whooping cough, that gas be allowed to escape and impregnate the atmosphere in sections where cholera is likely to appear, as a safeguard against the epidemic.

Upon this, as upon other points, doctors disagree, and so important a subject should be decided only upon evidence of the most convincing character. If detrimental to health to a degree to warrant it, let extreme measures be adopted. If it is simply disagreeable, the Board of Health have no jurisdiction on the premises.

MANAGEMENT OF GAS BURNERS.

Gas consumers, as a general thing, are very careless in regard to the management of their burners, and judging from cases which have come under our personal observation, we are inclined to the belief, that herein lies one of the most prolific sources of the numerous complaints made against the quality of the gas supplied by gas companies.

In many instances, stores, dwelling-houses, etc., are lighted by burners which, long since, have been rendered useless and wasteful by long usage, collection of dust, etc., in the outlet, and neglect to remedy any defects. Consumers in nine cases out of ten overlook this source of waste; and, applying no cure, obtain but a limited supply of light in proportion to the gas consumed, which deficiency is charged to the manufacturers, who, they allege, are supplying an inferior article.

We do not wish it to be inferred from these remarks that we are advocating the cause of the gas companies. Every intelligent person who has, or may, take the trouble to inquire into this subject, will admit the truthfulness of what we assert.

Consumers will learn from experience that a proper care of the burners is at all times essential to the maintenance of a uniform, steady flame, and after remedying any defects noticeable in the burners or elsewhere, will complain no more of the "poor quality" of the element that affords the best known artificial illumination. Remove the old and "played out" burners, substitute new ones, attach to each an efficient regulator, and our word for it, the consumer will obtain a satisfactory light, and at the same time economize greatly.

LUDLOW VALVE MANUFACTURING CO.

Perhaps there is no part of the apparatus and machinery for manufacturing, storing and conveying gas from the gas-works to the consumer more important to have perfect in construction and accurate in adjustment, than the stopcocks or valves which are to confine and regulate the flow of this remarkable element—so imponderable, so ethereal, and so difficult to prevent from escaping and mingling with its particular affinity, the atmosphere, owing to certain peculiar laws of exosmosis, endosmosis, and diffusion. The valves to govern these conditions are made from the size of the finger up to one and two feet in diameter, and the adjustment and fittings must be wonderfully accurate. In this connection, we beg to refer to the Ludlow Valve Manufacturing Company, of Troy, N. Y., whose advertisement will be found elsewhere. This Company has gained a national reputation for the various new and important improvements and styles it has introduced in this specialty of manufacture, both of gas and water valves; and we cheerfully recommend them to all needing said article.

OREIDE.

Oreide, the beautiful alloy resembling gold, is a French discovery, and consists of pure copper, 100 parts; zinc, or (preferably) tin, 17 parts; magnesia, 6 parts; sal ammoniac, 3.6 parts; quick-lime, 1.8 parts; tartar of commerce, 9 parts. The copper is first melted, then the magnesia, sal ammoniac, lime, and tartar in powder are added little by little, briskly stirring for about half an hour, so as to mix thoroughly; after which zinc is thrown on the surface in small grains, stirring it until entirely fused. The crucible is then covered, and the fusion maintained about 35 minutes, when the dross is skimmed off, and the alloy is ready for use. It can be cast, rolled, drawn, stamped, chaced, beaten into a powder, or leaves, and none but excellent judges can distinguish it from gold. Another beautiful alloy, the color of gold, is obtained with 90 per cent. aluminium, which must be perfectly pure, of the best quality, and in exact proportion. It is little affected by the atmosphere, and is strong, malleable, and homogeneous in structure.

THE NEW YORK GAS COMPANIES.—The resolution of Mr. P. Mitchell, providing for the appointment of a committee of seven to make inquiries concerning the gas companies of New York, Brooklyn and Buffalo, was called up and passed. The resolution directs the committee to inquire, first, whether such companies have, since their organization, made any returns of income, profits and dividends; if so, to what State officer, and the various amounts of the same; second, is the gas supplied of such a quality as to demand the price now charged? third, can the people be supplied for a more reasonable price with a superior quality of gas? The resolutions were carried.—*N. Y. State Assembly, Feb.* 15.

We understand the committee referred to above are in session in this city at the present time.

NEW PUBLICATION.

"ONWARD."—This is a neatly gotten up monthly, devoted to the youth of America, and edited by Captain Mayne Reid, who has the happy talent for writing highly interesting stories and adventures, graphically illustrated. "The Lost Sister" is worth a perusal. The Captain has been accused of drawing largely upon his imagination, upon a small foundation of facts. This, however, he does not deserve. His adventures are of such an extraordinary character that they *may* seem incredible to persons whose lives run in one track and as smooth as a valley stream. But the Captain has got the "knack" for seizing upon the fancy of his readers, and anything emanating from him is sure to cause a special rejoicing. We wish the Captain success in his new publication, which he has, doubtless achieved ere this.

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Make Valves ¼-inch to 24 inch, for Water, Steam & Gas.

FIG. 1.

Fig. 1 shows a single gate valve.

Fig. 2 represents wedge, one-half of double gate, intended for larger sizes of water valves required to bear heavy pressure either side.

The slides, G G, are held against wedge D, by ribs, H H, projecting from sides of valve body, A.

In closing the valves, when opening, I is covered, slides, G G, pass the lower ends of ribs, H H, when the wedge, D, can move forward on the inclined planes E E, and crowd the gates apart.

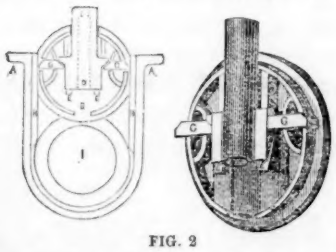

FIG. 2

[From A. F. Havens, Engineer Brooklyn Gas-Light Co.]

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[From R. E. Roberts, Secretary Detroit Water Works.]

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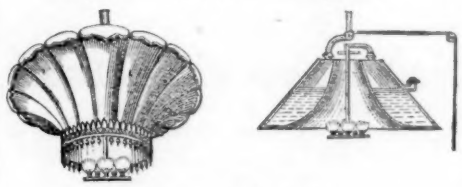

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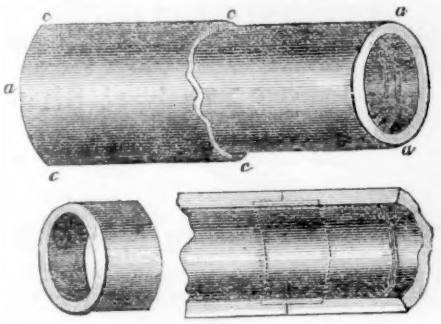

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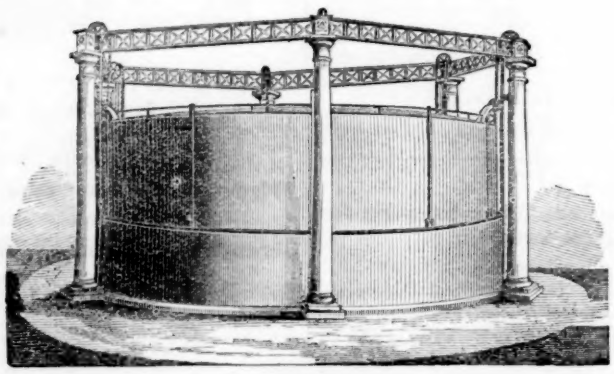

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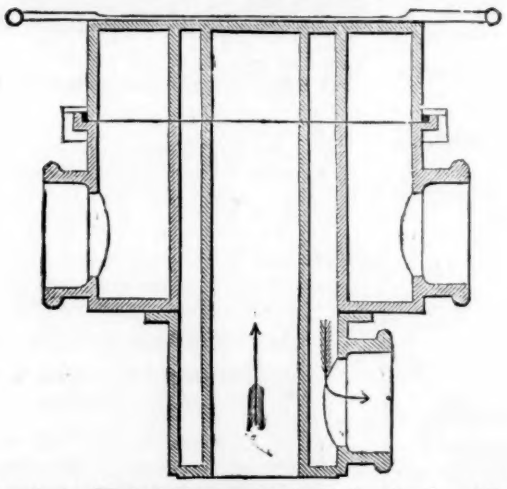

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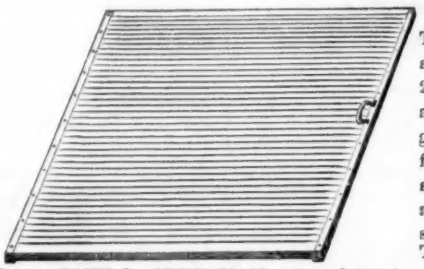

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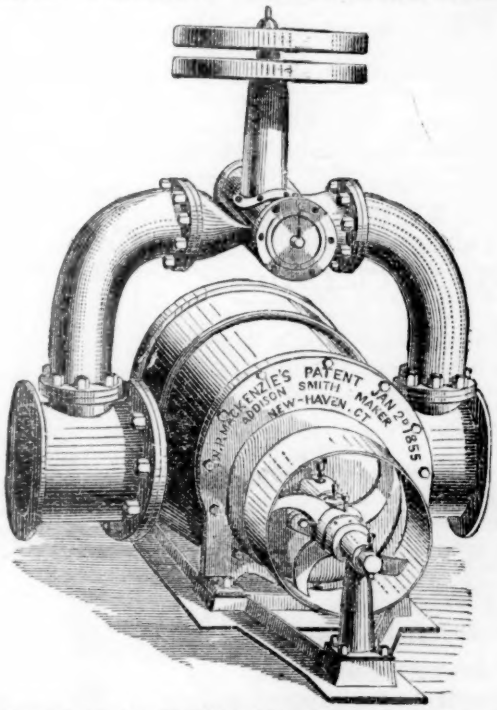

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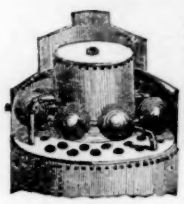

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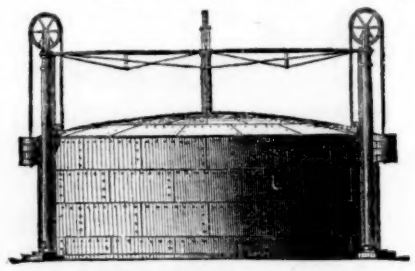

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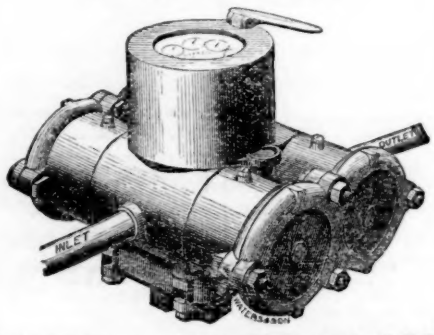

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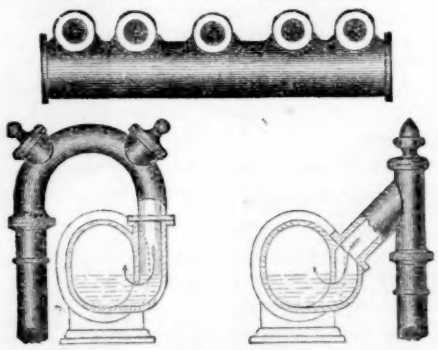

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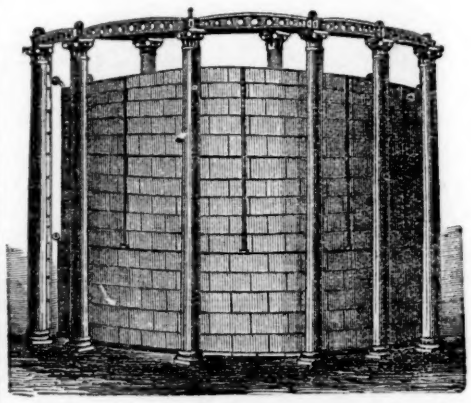

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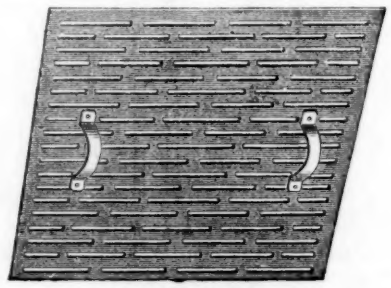

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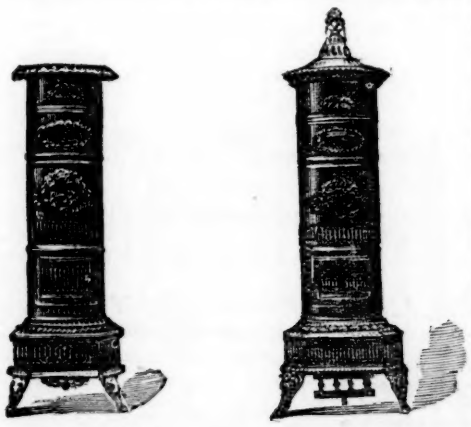

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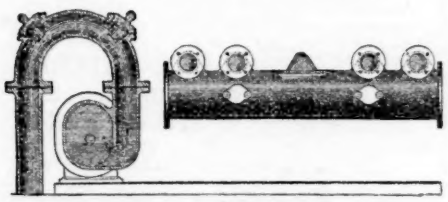

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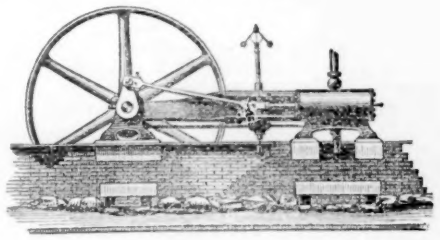

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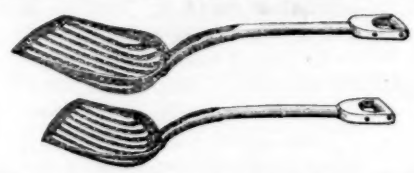

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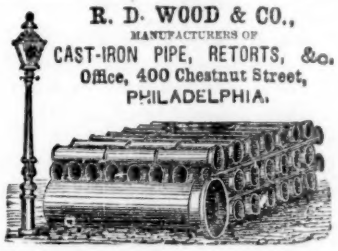

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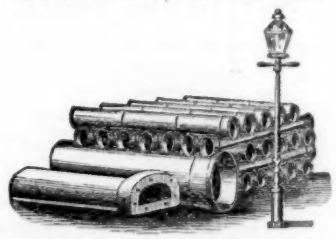

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ALSO

58 John Street New York. 171

REPORT OF THE TREASURER OF THE BATH (ME.) GAS-LIGHT COMPANY.

RECEIPTS.

Sales of gas	$11,076 39	
" " coal	15 84	
" " coke, coal tar, and cinders	109 75	
Rent and dockage	102 00	
Profit and loss	4,891 56	
	$16,195 54	
Cash on hand, Jan. 1, 1868	3,706 51	$19,901 05

EXPENDITURES.

Dividend, No. 14	$3,073 50	
Coal	6,553 27	
Lime	190 25	
Sundry personal accounts	632 01	
Repairs	401 15	
Coal shed	254 52	
Iron purifier covers	290 00	
Expenses	378 34	
Abatements and allowances	115 77	
Salaries	1,100 00	
Government tax	325 15	
Government license	10 00	
City tax—$5.85 ; discount, $29 25	555 75	
Pay roll at the works	1,698 00	
Bills receivable	962 58	
	$15,940 39	
Cash on hand, Jan. 1, '69	3,969 66	$19,901 05

ASSETS.

305 Tons of coal	$2,745 00	
36 Casks lime	54 00	
35 Gallons glycerine	70 00	
1 Retort, fire brick and tiles	151 00	
Bills receivable	962 58	
Meters	29 75	
61 Feet street mains	24 40	
Cash	3,960 66	
		$7,997 39

LIABILITIES—NONE.

Carbonized during the past twelve months, 887,040 pounds of "Lingan" and "Westmoreland" coals, making per station meter 2,896,260 cubic feei of gas, and delivered to consumers 2,461,319 feet—allowing 30,000 feet for gasholder, and consumption at the works —leaves 404,941 feet for condensation and waste. The company have 256 consumers, 25 street lamps, and about 2¼ miles of pipe laid. Capital stock, $68,300. Par value of stock, $100. No. 15—Dividend $5 per share, now payable.

We publish this report as a special case, to show besides other matters, the remarkably small percentage of loss by leakage, etc.—Eds. G. L. Jour.

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On filing each Caveat	$10
On filing each application for a Patent except for a Design	15
On issuing each original Patent	20
On appeal to Commissioner of Patents	20
On application for Re-issue	30
On application for Extension of Patent	50
On granting the Extension	50
On filing a Disclaimer	10
On filing application for Design (3½ years)	10
On filing application for Design (7 years)	15
On filing application for Design (14 years)	30

Miscellanea.

—The San Francisco *Mining Press* says in a recent issue that the Oakland Railroad Company are engaged in sinking an artesian well in the Bay of San Francisco, at the end of the railroad wharf, two-thirds of the distance from Oakland Point to Goat Island. The attempt is made in at least twenty feet of water at high tide. It is expected that soft water will be reached at no great depth under the bay.

—A Paris letter to the New York *Herald* states that the Chassepot gun is a complete failure, and one of the most dangerous weapons ever supplied to an army. Two or three systems of alterations have been tried, and it is probable that one on an American plan will be adopted, and with it a radical change in the character of the ammunition.

—A California paper says that the southern portion of that State is gaining in population rapidly, and that the Orizaba leaves her wharf crowded with passengers, standing room being scarcely left on board, and a large portion of them are in pursuit of lands for permanent homes at points from San Luis Obisqo southwards to the Mexican line. Another steamer is soon to be put on the route.

To Inventors and Patentees.

This Journal, circulating, as it does, throughout the United States, Canadas, and portions of Europe, is a superior medium for advertising.

Upon receipt of $3 we will send the Journal one year, and give a description of any new invention in a space not to exceed ten lines in the "Inventors' Department."

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Advertising Index.

☞ In looking for advertisements, see figures 1 to 9, within brackets, at head of advertisement pages.

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Arnold's Metallic Gas Trays—T. G. Arnold, 334 and 336 West 21st street, N. Y. 6
American Meter Company, 512 West 22d street, New York 8
Automatic Gas Purifier—State Rights for sale—Wm. C. Turnbull, care of T. C. Babcock, 50 Broadway, or office of the American Gas-Light Journal 2
Builder of Gas Works, Apparatus, Etc.—P. P. Delly, 39 Laurel street, Philadelphia 3
Cambridge Gas Stoves, Ranges, &c.—Gas Light Journal Offices, 8
Contractors for Gas-Works, Etc.—Murray, Baker & Walker, Fort Wayne, Ind 2
Gas Retorts, Etc.—George C. Hicks & Co., Baltimore, Md 8
Gas Fixtures, Etc.—Archer & Pancoast Manufacturing Co., 9, 11 and 13 Mercer street, New York 2
Gas Fitters' and Plumbers' Materials—McNab & Harlin, 56 John street, New York 3
Gas Coals—Bird, Perkins & Job, 104 Wall street, New York
Gas Engineers and Contractors—Hoy, Kennedy & Co., 111 Liberty street, New York 4
Gas-Burners—C. Gefrorer, 529 Commerce street, Philadelphia, Pa 9
Gas Meter Manufacturers—Harris & Bro., 1117 Cherry street, Philadelphia, Pa 8
Gas Superintendent—C. M. Cresson, 417 Walnut st., Phil., Pa 9
Gas Apparatus, &c.—Geo. H. Kitchen & Co., 561 Broadway 9
Gas Burners—Wightman Bros., 25 Kilby st., Boston, Mass. 9
Gas Burners—T. G. Arnold, 224 and 226 West 21st st., N. Y. 9
Gas Burners—W. Anderson, cor Franklin & Elm sts., N. Y. 8
Gas Stoves—A. L. Bogart, 792 Broadway 7
Gas Fixtures, Meters, Etc., Etc.,—McHenry & Carson, Cincinnati, Ohio 4
Gas Fixtures & Chandeliers—Alfred Bliss & Co., 95 Beecker-st., New York 4
Gasometers, Etc—George Stacey & Co. Cincinnati, O 6
Gas-works of London—D. Van Nostraud, 192 Broadway 3
Gas and Kerosene Fixtures, &c.—Tucker Mfg Co, 128 William street, New York; 117 and 119 Court street, Boston, Mass. 2
Gas Works for sale—superintendent, Tiffin, Ohio 1
Gas Fixtures, Etc.—Mitchell, Vance & Co., 597 Broadway 3
Gasholders, Etc.—Deily & Fowler, 39 Laurel street, Philadelphia 3
Hydrocarbon Light and Gas Improvement Company, Office 74 Maiden Lane, New York 3
Jersey City Gas Meter Works, 14 Morris st., Jersey, N. J 3
Ludlow Valve Mfg Co., 139 River street, Troy, N. Y 3
Patent Gas Exhauster—Smith & Sayre, 484 Broadway 5
Purifying Trays—Jno. L Cheeseman, 147 and 149 Ave. C. N.Y. 2
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Cast Iron Pipes and Fittings—B. S. Benson, 52 East Monument street, Baltimore, Md. 1
Continental Works—T. F. Rowland, Greenpoint 6
Erie Basin Iron Works—Elizabeth, Dwight and Van Dyke sts., South Brooklyn, N. Y. 6, 7
Keystone Iron Works 3
Louisville Pipe Works—Dennis Long, Cor. 9th and Water-sts., Louisville, Ky. 9
Manufacturing Enamelers—Nessle & Taylor, 97 Water street, Brooklyn, N. Y. 7
National Foundry and Pipe Works—Wm. Smith, Carroll, Pike, Smallman and Wilkins streets, Pittsburgh, Pa 4
Oregon Iron Foundry—Herring & Floyd, 738, 740, 742 and 744 Greenwich street, New York 3
Pascal Iron Works—Morris, Tasker & Co., Philadelphia, Pa. 9
Southwark Foundry—Merrick & Sons, Fifth and Washington streets, Philadelphia 9
Wrought Iron Pipes, etc.—Joseph Nason & Co., 61 Beekman street, New York 4

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Ashcroft's Low-water Detector, 50 John street, New York 6
Aubin Water Meter—H. Q. Hawley, Albany, N. Y. 7, 9
Babcock & Wilcox's Stationary Steam Engines 8
Davis' Steam Superheating Boiler—Duplex Steam Boiler Mf'g Company, Long Island City, N. Y. 9
Pat. Lead-Encased Tin Pipes—Colwells, Shaw & Willard, foot of West 27th street, N. Y. 4
Patent Dry Centre Valve—American Meter Company, 512 West 22d street New York 5
Steam Pumps—H. R. Worthington, 61 Beekman st. New York 7
Water Pipes, etc.—S. Fulton & Co. 207 North Water st. Phila. 9
Water Closets, etc.—Wm. S. Carr & Co. 149, 151, 153, 155, 157 Centre street, New York 4
Water and Sewerage Pipes—Am. Water and Gas Pipe Company northwest corner of Green and Bay sts., Jersey City, N. J. 5
Worthington's Water Meters—H. R. Worthington, 61 Beekman street, New York 6

CLAY RETORT WORKS.

B. Kreisher, Clay Retorts, Etc., 58 Goerck street, New York 5
Bay State Clay Retort Works, 125, 127 Water st. Boston, Mass. 6
Brooklyn Clay Retort Works, Van Dyke st. Brooklyn, N. Y. 5
Jersey City Fire Brick Works.—J. H. Gautier & Co., Greene, Essex and Bergen streets, Morris Canal Basin, N. J. 5
Laclede Fire Brick Works, 1067 North Levee, St. Louis, Mo. 3
Manhattan Clay Retort Works, 15th st. near Av. C, New York 5
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Street Lamps—J. G. Miner, Morrisania, Westchester Co., N.Y. 2
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MISCELLANEOUS.

A Rare Opportunity for Investment—Offices of this Journal 8
Apparatus For Sale—Washington (D. C.) Gas Company 6
Bird Cages—Osborn Manufacturing Company, 109 Bleecker st. 8
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Fodeli's "Book-keeping for Gas Companies" 2
Gas-Light Journal American and Foreign Patent Agency 8
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Professor Henry Wurtz - Office Gas-Light Journal 3
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Situation Wanted as Manager of a Gas Work 3
Steam Cooking Apparatus—Bennett, Johnson & Co., 42 Dey st., New York 6
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Situation Wanted by an Engineer of many years, Experience 6
Shackelton's System of Heating—22 Pine-st., Room 10, N. Y. 8
Treatise on the Manufacture of Gas—D. Van Nostrand, 192 Broadway, New York 8
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Works on the Manufacture of Gas—D. Van Nostrand, 192 Broadway, New York 2

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AND

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☞ All communications to be addressed to "The Editors," No. 22 Pine Street, New York.

APR 8, 1869

SUPPLEMENT
TO THE AMERICAN
GAS-LIGHT JOURNAL

NEW YORK, TUESDAY, MARCH 2, 1869.

[*Continued from page* 262.]

Q. You stated that the oxide of iron of the New York Works evolved ammonia; where did it get this? A. I do not recollect what I stated in my direct testimony; of course the ammonia must come from the gas.

Q. The oxide of iron does, then, absorb the ammonia from the gas. A. It does.

Q. Is there any affinity between lime and ammonia? A. There is; there is a double compound of lime and ammonia—the carbonate of lime and ammonia, a salt distinctly recognized. At the same time every chemist understands perfectly, that the action of quick-lime is to decompose ammoniacal salts and set ammonia at liberty, and it is for that express purpose that quick-lime and sal ammoniac are employed for the evolution of ammonia. In the ordinary dry-lime purification, the ammonia is of course in the largest measure removed by the water of the hydraulic main and the water of the scrubbers, and but a small portion of the whole product finds its way into the purifying boxes, and that chiefly as a sulphide of ammonium. I believe I have already explained that method of decomposition sufficiently—the ammonia and the effete lime.

Q. Has not iron a positive and well recognized affinity for ammonia? A. It has—the hydrous sesquioxide of iron, which is a common iron ore, is well known to absorb and retain it with obstinacy, and this property it possesses in common with ordinary clay, and it is to this joint effect that Liebig and other agricultural writers attribute the peculiar value and efficiency of clay in soils for the retention of ammoniacal salts.

Q. Has not iron a stronger affinity for ammonia than lime? A. Certainly

Q. In your direct examination, in stating the advantages of the lime process over the iron process, you gave as a reason that the lime more effectually removed the sulphur, carbonic acid, and ammonia; what reason had you for embracing ammonia? A. The ammonia is not removed in the lime process as ammonia. It is not in that form that it occurs in the lime purifying boxes. It exists there solely as sulphuret of ammonium or ammonic sulphide, and it is from the decomposition of this salt, under the conditions which I have already described, that the powerful ammoniacal odor arises which is exhaled when the atmosphere commences its action upon the effete lime. I think I remarked in the same connection, as far as I can now recall my testimony, that I did not regard the presence of a small proportion—say not exceeding four or five grains of that substance in one hundred cubic feet of gas—as in any degree prejudicial to the consumer; but on the contrary that I thought its presence to a moderate extent—not exceeding that amount,—desirable, and that it was even desirable that there should be so much present that it would react upon turmeric paper, for the important reason that the presence of ammonia under these conditions secures the sulphur in a harmless form, since in the combustion of the sulphur the whole of that product appears as sulphurous acid. If ammonia is also present at the same instant, the two substances unite in the form of sulphite of ammonia, a salt which is white and harmless, and may be often seen condensed upon the under side of the metallic bells that are hung above the chimney of an argand burner. The coating which lines the chimney, when it is moist and freshly made, and which may be seen afterwards when dry as a frosty looking deposit, is the salt of ammonia produced in the manner which I have indicated; and hence I regard the presence of the small trace of ammonia which is usually found in gas, as rather beneficial than otherwise. The allegation that it produces nitric acid or nitrous acid in its combustion, appears to me to be of doubtful application; at all events I have never seen the evidence of the presence of nitric acid under these circumstances.

Q. Then you do not regard its presence in gas as an objection to the iron process? A. Not at all—no, not to the extent specified. It is, of course, quite possible for the gas manufacturer to send his gas to the consumer so imperfectly purified of ammonia, that its presence hall become a nuisance. It is then altogether probable that nitric acid vapors will be produced in a noticable quantity, and a peculiar greenish, non luminous character given to the color of the flame. This may be recognized by the eye. I have often observed it as every other careful observer must have done, in noticing gas in the act of combustion.

Q. That inferiority would be more likely to exist in gas purified by lime than that purified by iron, would it not? A. I do not know that it would.

Q. Is it not true that the London gas purified by iron is claimed to be remarkably free from ammonia? A. The parliamentary act—the gas act—allows the presence of five grains of ammonia; and I observed in a recent discussion on that subject which took place within the present month in London, that a distinguished gas engineer, Mr. Hawksley, speaks of the presence of ammonia as being easily recognized, by turmeric paper, in the London gas. I do not remember of what particular company he spoke. I have quoted Mr. Hawksley as the authority. It occurs to me since doing so that it might possibly have been one of the other gentlemen who were involved in that discussion, which took place on the occasion of Dr. Odling's lecture before the Board of Health. In the *Journal of Gas-Lighting*, published at London, July 7th, 1868, page 524, Dr. Odling says—"The next constituent of coal gas to which I shall call your attention is ammonia. The proportion of ammonia in London gas is very small. We find that one grain of ammonia in one hundred cubic feet of gas is sufficient to affect turmeric paper, upon which ordinary London gas is used, without, or almost without, action."

Q. Would you regard Dr. Odling an authority upon that question? A. I have quoted him as such. I was going to quote him against himself. I have his lecture of the 2nd of February, 1869, here.

Q. The gas referred to by him is purified by iron. Is it not the ordinary London gas he speaks of? A. He does not say so, but I presume such is the fact. With your permission I will read what Dr. Odling says in his lecture before the Metropolitan Association of Medical Officers of Health, published in the "London Journal of Gas-Lighting" for the 2nd of Feb'y, 1869.

Q. What does it refer to? A. This question of ammonia.

Q. The presence of ammonia in gas? A. Yes, sir. It is in support of what he says before: "I suppose I must say that all coal gas contains some ammonia—that is to say it contains some, chemically speaking, so that if it were required to recognize it, ammonia might be detected in any coal gas whatsoever. The greater part of the coal gas supplied in London, however, contains but a very small portion of ammonia. The act of Parliament requires that coal gas shall be so free from ammonia as not to affect turmeric paper, and ordinarily the gas in London either does not or only just does affect turmeric paper. When we bear in mind the extreme delicacy of this test—I think it has been calculated that one grain of ammonia in 100 cubic feet of gas will affect the test paper decidedly—you may infer that the ammonia in ordinary gas, where it does not or does only just affect the test paper, is so small as to allow of its being disregarded. At the same time where the ammonia does exist in any quantity, it is certainly objectionable. There is no doubt that by its combustion it produces a certain amount of nitric acid, which is prejudicial in many ways, and that the ammonia itself is prejudicial to the brass caps and fittings."

I believe that is the latest testimony we have on that subject. I would remark in that same connection, that I have lately determined the quantity of ammonia in gas, which I have been making, under a series of experiments, in connection with Professor Wurtz, in New Haven, with the hydrocarbon process, and I have found that it amounts to but little more than half of one grain in 100 cubic feet of gas, but that the gas which is furnished to the city of New Haven being made by a different process is considerably richer, in ammonia, although still within the Parliamentary restriction.

Q. How much richer? A. I cannot give you the figures until I calculate them: I have them in my pocket. I have not calculated the result.

Q. Does it color turmeric paper very distinctly? A. Very decidedly—very distinctly. The other does not; it does not affect the turmeric paper at all. It falls within the observation of Dr. Odling, that one grain of ammonia in one hundred cubic feet of gas will affect turmeric paper.

Q. Then it must contain more ammonia than the London gas? A. I think it probably does, but I am not prepared to say that as of authority, for I have not the exact figures.

Q. I believe you have already stated, that the New Haven gas is purified by the dry-lime process? A. Always.

Q. In the fifth edition of Clegg's "Treatise on Coal Gas," published in New York in 1868, page 196, he states:—"By none of the processes of purification we have described is bisulphide of carbon effectually removed; nor has any process yet been discovered by which gas can be purified on a large scale from this compound of sulphur. The metropolitan gas companies have consequently been unable to comply with the conditions required by the Metropolis Gas Act of 1860, that the gas shall not contain more than twenty grains of sulphur in every 100 cubic feet. The gas companies who supply the city of London applied to Mr. Barlow, in 1864, to ascertain whether it was practicable by any known process to abstract the sulphur compounds so as to attain the required standard of purity. Mr. Ellisen, the chemist of the experimental works of the Paris Gas Company, instituted numerous experiments with that object, but the conclusions they arrived at were not encouraging." Would you agree with Clegg in that statement? A. Not entirely, for reasons that I would state. My own experiments upon the presence of bisulphide of carbon or carbonic disulphide in coal gas have not been such as to leave upon my mind the impression that this form of sulphur is of so frequent occurrence as is stated in nearly all literature on gas chemistry. I have diligently sought for that product by the best accredited methods in the case of the company of which I am the chemist in New Haven; and in gas which I had especially made, by experimental processes, from various sources, for myself, and I have not detected it. I do not mean to be understood to say that it does not occur, or occur frequently, in London gas; chemical testimony about that point is explicit; but I do mean to be understood as saying, that I do not regard it as by any means so frequent or of so universal occurrence as is stated. I believe at our last interview (as well as I recollect my testimony) that I made the statement which I now repeat, that there was, in my judgment, good reason to believe that the form in which sulphur more frequently exists than in any other in coal gas, was that of sulphocyanide of ammonium—the comoustion of course resulting in the production of sulphurous acid. I also stated, as I believe, in my direct testimony, that it was the current opinion of the best gas-engineers who have written upon this subject, as far as I know, that the lime process is more effectual in removing the sulphur than the iron process; and the evidence, as produced in the discussion before the British Association of Gas Manufacturers, which was quoted on a former occasion, was adduced in support of that opinion: and that opinion I now reiterate, that it is not possible for the iron process so closely to remove the sulphur, as it is ordinarily conducted—I mean, as in the dry-lime process. If the dry-lime or other lime process is added as a supplement to or a portion of the iron process, then the sulphur will be as effectually removed in the one case as in the other.

Q. Dr. Letheby, in his quarterly report on the supply of gas in the city of London, given in the *London Journal of Gas-Lighting*, July 21st, 1868, page 562, states that the average quantity of sulphur has not been excessive, though in 46 out of 160 cases, the quantity of this impurity exceeded 20 grains per 100 cubic feet. The Great Central Company's gas averaged 14.54 grains, the Chartered Company's gas averaged 18.86, and the City Company's gas averaged 18.97 grains. Do you regard that statement as authoritative? A. Of course—it is official.

Q. Do you regard the proportion given in that statement as excessive. A. It falls, as an average, within the parliamentary act. In that sense it certainly is not excessive.

Q. The Companies referred to in this statement do

not use the dry lime process, do they? A. I presume not. It is a point granted, that in London they use the iron process exclusively.

Q. Do you consider Professor William Odling, professor of practical chemistry at Guy's Hospital, and Secretary of the London Chemical Society, an authority upon practical chemistry? A. I have already had the pleasure of answering that question more than once, and I shall be happy to reiterate, as often as you repeat it.

Q. Have you read the following statement by that gentleman, on page 562 of the journal last cited, July 21st, 1868? A. I presume I have. I read the article at the time of its appearance—the same being in his lecture to the British Association of Gas Managers:

"So far then I am a little at issue with gas managers in being disposed to admit, that ordinary coal gas contains a greater amount of sulphur in some form or other than they are willing to allow, and than the letter, though not the spirit of the act of parliament, permits; for the act was framed upon the results furnished by an incomplete combustion of the gas, and condensation of the products. But, on the other hand, I am altogether at issue with the public when they maintain that the sulphur of gas produces, by its combustion, oil of vitriol, or that the amount of sulphur ordinarily contained in gas is of any consequence whatever; and a little consideration will, I think, satisfy you of the soundness of this position. We will assume that coal gas contains, not 20, but 40 grains of sulphur in 100 feet—a quantity at any rate greatly exceeding the reality. Now making the extravagant assumption, that the whole of these 40 grains of sulphur would be completely burnt—and in reality they would be burnt very incompletely—they would furnish by this combustion 80 grains of sulphurous acid gas. This quantity of the produced sulphurous acid would occupy, at ordinary temperature, about one-fifteenth part of a cubic foot, and since 100 cubic feet of our coal gas gives one fifteenth of a cubic foot of sulphurous acid, 1,500 cubic feet of our coal gas would be required to furnish one cubic foot of the acid, even upon the extravagant assumption we have purposely made. But the combustion of 1,500 cubic feet of coal gas would produce something besides sulphurous acid. It would produce, at least, 1,000 cubic feet of carbonic acid, and in addition to its dilution by other gases and vapors, we should have our sulphurous acid diluted by 1,000 times its volume of carbonic acid. Now, if we can get at the proportion of carbonic acid in the atmosphere of a room highly illuminated with gas, and take the 1,000th part of that proportion, we shall be able to form some notion of the amount of sulphurous acid present. You will remember that the amount of carbonic acid furnished by the breath of one individual is equal to that furnished by two three feet gas burners, and that the maximum amount of carbonic acid found in the atmosphere of a crowded theatre was .32 per cent. Now if, in addition to our previous unreasonable supposition, we further suppose that an atmosphere contains .2 per cent. of carbonic acid furnished by gas combustion, you will see that the whole matter becomes a *reductio ad absurdum*—that we might actually have one half millionth part of sulphurous acid present in the air of a gas-lighted room.

"But this sulphurous acid is not sulphuric acid, and can only be converted into sulphuric acid with very much pains and difficulty, as all who have tried the experiment of converting the sulphur of coal gas into sulphuric acid are painfully aware. When gas is burned in special apparatus, indeed, its constituent sulphur can be converted into sulphuric acid, but it is very difficult to do this. The probability is, that of the sulphurous acid produced in ordinary combustion, scarcely a particle gets converted into sulphuric acid—certainly not more than the ammonia ordinarily existing in the atmosphere can neutralize, so as to form sulphate of ammonia instead of sulphuric acid."

A. Yes, sir; I am familiar with the statements alluded to.

Q. Is not sulphurous acid an excellent disinfectant? A. No. I do not know that I should rank sulphurous acid as a disinfectant. I recognize it as an excellent antiseptic. There may be some confusion of terms in this regard. I regard chlorine as an excellent disinfectant, but I do not propose to fumigate my parlor with it.

Q. In the pamphlet on the application of disinfectants in arresting the spread of the cattle plague, by William Crookes, F. R. S., at page 20, is the following statement, entitled "Sulphur Fumigation":—

"Of all disinfecting processes this is perhaps the oldest. Its action was well known in the days of Homer, for we read that Ulysses employed it to remove the smell of dead bodies. It is recorded by Ovid, that the shepherds of Italy yearly purified their flocks and herds with burning sulphur, and passages in other writers show that they averted diseases from them by this means."

Would you agree with that statement? A. I believe that sulphurous acid is a very powerful agent in destroying the germs and spores from which contagious and other diseases are propagated, and have so stated in my testimony already given.

Q. Is not an agent that removes infection, as you state, a disinfectant? A. I suppose it would ordinarily be so classed, still the terms are used with a good deal of vagueness. Sulphurous acid is a well known specific agent for the cure of cutaneous diseases, a property which it enjoys in common with sulphur, from which it is produced, and for fumigation in hospitals, for which purpose it is of long standing and with satisfactory results.

Q. Are you confident that the smell you perceived near the ceiling in the room where gas was burning—as described in your direct examination was sulphur? A. I did not say it was sulphur; I said it was the smell of sulphurous acid and sulphite of ammonia, producing the well known choking effect which makes the stifling atmosphere observed in an ill ventilated room in which numerous gas-lights are burning. I did not say it was sulphur—it is a very different thing.

Q. You stated that when the oxide of iron is ventilated in the purifiers it becomes heated and sets fire to the screens—is any difficulty of this kind experienced in the New York works? A. In the New York works the iron is not ventilated in that manner. It is ventilated upon the floor. They do not ventilate their iron in boxes—the case is entirely distinct.

Q. Then there is no necessity of ventilating the iron in the purifiers? A. Not unless you wish to prevent a stink.

Q. What stink did you refer to in your answer? A. That which is described as so noisome by some English authorities as exhaled from the effete iron.

Q. You never noticed that. A. I referred specially for authority to the description of the Rev. Dr. Bowditch.

Q. You did not notice that offensive smell in your visit to the New York Gas Works? A. No. My recollections in regard to the visit in question are a little indistinct, as I have stated in my direct testimony. I remarked on that occasion, that I visited the works for the purpose of examining into the economic character of the process, rather than its sanitary character, and paid but little attention to the stench.

Q. You are not aware that the oxide of iron used in the gas works at Copenhagen is daily ventilated in these boxes? A. I know nothing about the Copenhagen works.

Q. You stated that you visited the New York works last summer, among other things to ascertain the economic value of their process—what experiment did you then and there make? A. I made no experiments other than the ocular observation of the character of the gas which I noticed in the photometer rooms, or dark room, in which I found it burning.

Q. How did you know then that the gas produced at these works was not as pure as when purified by lime? A. I only inferred from the investigation of the gas, that it was a gas of low quality, and that as such it undoubtedly contained a portion of carbonic acid to which its low illuminating power was attributed. It is well known that the presence of even a moderate quantity of carbonic acid very greatly depresses the illuminating power of gas.

Q. Could you detect the difference of one or two candles in the illuminating power of gas without the aid of the photometer? A. Two candles very readily, unless the gas was of very high or low illuminating power; anywhere between the range of twelve and sixteen or twelve and eighteen candles. I could detect with my eye the difference of two candle power readily. That is a matter of habit which grows upon one from constant use of the photometer, and daily personal observations with which I am familiar.

Q. In the German edition of Muspratt, vol. 3, at page 1522, is the following statement which I will ask Prof. Chandler to translate.

(Professor Chandler translated as follows:)

In speaking of the material used in purifying gas, Muspratt states that—

"Of all these materials, Laming's mixture and the iron ore have obtained the most general or prominent introduction. Laming's mixture has, above all others, particularly lime, essential advantages. After being once used it can be re-generated and used again. According to Unruh's experiment in Magdeburg, the purification from sulphuretted hydrogen takes place so coupletely that one cannot detect the smallest trace by the most delicate re-agents, and the quantity of carbonic acid in the gas is extremely small;—the illuminating power not less than when lime is employed; and the smell of the foul mass trifling."

Do you regard that as good authority? A. I do not know the author of the article in question—whether it is attributed to Dr. Muspratt or to the German editor, Kerl. I can only say that it is a difference of opinion between many authorities, and that this statement is at variance with the current literature of English gas engineers.

Q. From the same author and volume, page 1523, is the statement that Prof. Chandler will read, entitled, "Purification with iron ore:"—

"This ore is often cheaper or more easily obtained than Laming's mixture, and is regenerated at first slower and afterwards more rapidly. At the new City gas works in Berlin, the ore obtained in Upper Silesia is employed. In the gas works in Hanover the fine pulverized ore of Lunenberg mixed with spent tan and refuse dye wood is employed."

Do you regard that statement as authoritative? A. I regard it in the same light as the other statement by the same author. It is an illustration of the difference of opinion that competent authorities entertain with regard to the same method.

Q. Do you recognize "Wagner's Chemical Technology" as good authority? A. I do.

Q. At page 699 of that work it is stated that—"Much more important than all the previous methods of purification and really establishing an era, is the process of R. Laming in 1847.

Q. Do you regard Bloxam as good authority? A. He is a good chemist.

Q. In his chemistry, at page 450, referring to Laming's process, he says—"A great many other methods have been devised for the purification of gas from sulphuretted hydrogen, but none appear to be so efficacious and economical as that which consists in passing the gas over a mixture of sulphate of iron (green vitriol or copperas) slacked lime and sawdust, which latter is employed to prevent the other materials from caking together. The lime decomposes the sulphate of iron, forming sulphate of lime and hydrated oxyd of iron." Would you agree with that statement? A. So far as I know, the statement is correct. I mean, of course, in that answer that it is a correct statement of Laming's process, so far as I understand it. I do not necessarily give in my adhesion to the inference which he draws from it.

Q. In Wagner's "Year Book of Chemical Technology," vol. 9, page 713, it is stated in regard to the cheapness of the lime process. He simply states that the expense of purification is reduced to nothing by virtue of the value of the sulphur which is extracted from the foul oxyd. Have you any reason to doubt that statement? A. I have no reason to doubt the statement, though I have never seen that statement confirmed elsewhere. It has often been mentioned as an advantage of the iron process that the sulphur could be extracted from it.

Q. In Bowditch's work on the use of coal gas, London edition, 1867, at pages 19, 20 and 21, are the following statements:—

"About this date the use of gas (that was in 1844, the date referred to), the gas companies in London, and in some of the large towns, were sadly encumbered with and troubled about the lime refuse which arose from purifying their gas. Purified, the gas must be. Sanitary regulations most properly prevent the running of blue Billy—wet lime refuse—into streams and rivers, and in some cases prohibited the carting away from gas works, of dry lime refuse during the day time. Matters seemed to be approaching a crisis, when in 1849, Mr. Hills came to the rescue and introduced hydrous sesquioxyd of iron as a purifying agent instead of lime."

* * * * * * * *

"When a certain quantity of sulphur has been set free in a mass of oxyd of iron it becomes useless—not because its chemical affinity for sulphuretted hydrogen is destroyed or even lessened, or because the ore has lost the power to restore it when it is foul, but because it is clogged with inert sulphur. Mr. Hills further showed that when thus useless as a purifying agent the oxyd yet had a value, for the accumulated sulphur could be converted into sulphuric acid, and for this purpose the oxyd was worth what it cost at first, and in some cases I believe even more. This was an enormous boon to urban gas companies. It delivered them from a great difficulty in reference to the foul lime, and taught them how to free their gas from sulphuretted hydrogen, without any cost for material to do so."

* * * * * * * *

"The use of lime after the oxyd would remove the carbonic acid from gas, and need not produce any nuisance or involve more than a nominal cost, as the lime might be fit for use for the removal of carbonic acid over and over again. The evolution of the sickening vapors emitted by foul oxyd need not be a serious annoyance, as the oxyd can be revivified in the purifiers themselves, or in a building whence all effluvia can be carried through fires into the atmosphere, so as to be harmless." Do you agree with the statement read? A. I accept Mr. Bowditch's statement of the iron process as an exhibit of its claims, but I observe that he recognizes the noisome exhalations which the iron gives forth, and suggests a method for their removal which is essentially the same thing which has been recommended already for removing the similar nuisance from lime—a method of ventilation which was tried here in the Manhattan Company, and blew up the chimney which they built for the purpose, and destroyed considerable property.

Q. In the "Manual of Elementary Chemistry," by George Fownes, late Professor of Practical Chemistry in University College, London—the London edition of 1868, edited by H. Bence Jones and Henry Watts, at page 180, he says—"The use of lime, however, has

been almost superseded by that of a mixture of sawdust and iron oxyd." Do you agree with that statement? A. I do. That is a historical statement of the condition of the art in Great Britain and Europe.

Q. Do you recognize Professor E. D. Mapother, M.D., as a good authority upon sanitary science? A. Yes.

Q. In his lecture upon public health, Dublin edition of 1867, at pages 53, 54 and 55, are the following statements—"In both the gas works the mode of purification had been by the wet lime process, and the resulting refuse was conveyed into open tanks for the purpose of allowing the undissolved lime to settle from it. This lime was afterwards used as luting for the retorts, and the water is pumped under the furnaces, where it is consumed. At the open part of the sewers in Benson street, which has been recently covered in, about thirty yards from where the boy was suffocated in July, 1864, this refuse water might have been often seen. I believed that sulphuretted hydrogen escaped from the tanks while the refuse was exposed to the air, from the luting of the retorts, and from the water while being dried upon the furnace pans, and I am convinced that such escape was most injurious to the health of the workmen and surrounding population. My opinion was painfully verified by the suffocation of three men by sulphuretted hydrogen, in a pit dug on the premises of the Alliance works, in September, 1865. The lime refuse must have percolated from the tanks into the surrounding earth. Unwilling that so great, and in the beginning so expensive a change should be urged upon the companies, without my opinion being supported by London and other authorities, I wrote to the Medical Officers of Health of nine English districts. All condemned the lime process, and approved of the iron process, except one eminent chemist, who stated that with proper precaution the wet lime process need not be a nuisance, injurious to health. I also consulted several eminent gas engineers, and quoted authorities such as "Muspratt's Chemistry," "Barlow's Chemistry of Gas-Lighting," "Hughes Treatise on Gas Works," and thus produced much evidence upon the noxious character of the wet lime process in a populous town. In order to determine the matter by personal inquiry, the corporation commissioned me to examine the works in London and other English towns, during October, 1860, and I accordingly visited the London, City of London, Phoenix, Equitable, Chartered, Imperial, York, and Scarboro works, and ascertained that, in all the lime process had been found to produce nuisance, and that, therefore, the oxide of iron process has been substituted. * * * * * * * *

The only company which we now have, has entered into a contract for the erection of purifying chambers by the iron process, during summer, when alone extensive changes can be made in gas works, and they will be in action immediately."

Q. Do you accept these statements as authoritative? A. I understand these statements as applicable in the instances cited about the wet lime process. I do not understand that the wet lime process is on trial here. Nobody proposes to introduce that. It is not used in more than two or three companies in the United States, as I have before stated; and it is where the blue Billy cannot be disposed of at once into the ocean an unquestionable nuisance.

Q. Would not the fact that the authorities spoken of by this author introduced the iron process in preference to the dry lime process, go to show that they did not deem the dry lime process as furnishing the remedies? A. They have been compelled by the municipal regulations to introduce the iron process into most of the towns of England. It is not from choice, but from necessity, as I understand, that this change has been effected in the majority of the cases.

Q. What authority have you for stating that the Metropolitan company use Boghead coal in the manufacture of their gas? A. I saw the coal there, and obtained a portion of the coal there for my own use.

Q. Was not that temporarily used? A. I only mentioned Boghead as one of the enriching coals that they used.

Q. The inference might have been that they were in the habit of using "Boghead." A. They used, I said, either "Boghead" or "Wigan," or "Lesmahago" or some other well accredited cannel coal. All those I saw there, and could speak of from my own knowledge That is my authority—my own personal observation.

Q. Is your opinion that the gases evolved from refuse lime employed in the purification of gas are harmless, based upon actual knowledge of the effect of these gases upon the blood? It is based upon an actual knowledge of the effect of these gases upon living men—human beings—in the vicinity of the gas works, and through a long course of observation. I have never made any experiments as to the effect of the introduction of this gas into the arterial or venous system of man. I believe my opinion of that subject was fully expressed on the occasion of our last interview in answer to a question which the learned counsel addressed to me, in respect to Dr. Ure's testimony in regard to parties being suffocated in a pit.

Q. You spoke of them as being drowned in the gases? Yes, sir.

Q. How far from the gas may sulphide of ammonium be floated before it becomes so transformed as not to be perceptible to smell? A. No very considerable distance.

Q It would vary, I suppose, with the varying conditions of the atmosphere? A. Compared with the distance to which the heavy and persistent odors of the hydro carbons are floated, to which just objection is made on the score of offense.

Re-direct examination by Judge Van Vorst:

Q. I would like to ask you whether the process called the Laming process is in use in the United States? A. Not to my knowledge. The only gas works that to my knowledge certainly is employing an iron process is that one which has been so often mentioned in the city of New York, and they do not employ Laming's process, but a modification of the English or European iron process in which, as already explained, a variety of bog ore or sesquioxide of iron is mingled with a certain proportion of iron turnings, the whole mass drenched with ammonia water, and mingled with charcoal and exposed to the atmosphere after oxydation, for the purpose of revivification.

Q. You know nothing about Laming's process except as you have read of it in gas literature? A. I have never had the opportunity to study Laming's process, and know it only by reading.

Q. Do you know by reading whether it is adopted in Europe to any extent? A. I believe it to be adopted to a considerable extent in some parts of Europe.

Q. In some parts of Europe, Professor Silliman, do you know anything of what the advantages or disadvantages of it are, as compared with the dry lime process. A. I believe I have already pretty fully stated my opinion upon that subject in the direct testimony, and also in the cross examination.

Q. Now, with regard to the wet lime process of which you have spoken—that you say is in use in Boston? A. In Boston, and in use in Providence.

Q Do you know whether it is in use in any other part of the country? A. I do not know it to be in use elsewhere than in those two places.

Q In your opinion the fouled lime, unless it may be removed by being cast into the ocean at once, is a decided nuisance? A. It is a very decided cause of offense.

Q. How would it compare with the dry lime in that respect? A. In that regard, it is more offensive than dry lime. It does not present the same opportunity for removal. This fouled lime must be removed in close vessels of some kind, or if suffered to remain in sewers, or in streams, it would become a very just cause of offense.

Q. You stated that the ventilation of the oxide of iron in the boxes, destroyed the boxes? A. That is a statement which has been very frequently quoted in my direct testimony.

Q. If it could be ventilated in the boxes the noisome odors of which you have spoken might be avoided? A Undoubtedly, if a system of ventilation could be adopted which would prevent the too high temperature, I see no objections.

Q. You say there had been an experiment, as you understood—something toward ventilating it in the boxes—tried by the Manhattan Company with regard to the lime?

A. Yes, in the case of lime.

Q. Did they not attempt to ventilate the lime there in the boxes? A. The case to which I alluded is this: They attempted to adopt substantially what is known as the Palmer process of ventilation, which consisted in expelling the air which had been drawn through from the boxes, carrying with it the offensive odors into the bottom of the stack or chimney provided for that purpose, with the expectation of burning it in that stack; but the result was an explosion, resulting from the mingling of the gas and the atmospheric air, which destroyed the stack and blew the engineer out of the window, and damaged property to a considerable extent.

Q. And subsequently to that they have made additional improvements? A. They have adopted an entirely different method of ventilation, which has already been explained in the previous testimony.

Q. Now, do you know whether that method of ventilation of the fouled lime adopted by the Manhattan Company, of which you have spoken in terms of commendation, prevails anywhere else in the United States or in Europe? A. I am not aware that it has been adopted anywhere else in the mode it has been adopted there.

Q. Did you regard that, then, on the part of the Manhattan Company as an experiment? A. I regarded it as a successful experiment.

Q. But as an experiment nevertheless? A. It is an experiment of their own introduction. I do not regard it as an experiment if that implies a doubt of its success.

Q. Would you regard that as an improvement? A. Yes, sir.

Q Do you know whether it is or is not the subject of a patent? A. I do not know anything about it.

Q. How late is it that that method of ventilation of the fouled lime in the Manhattan Company has been communicated to the public to your knowledge? A. It has been well understood among gas-engineers and persons interested in gas-purification for more than a year that the Manhattan Company had achieved a success in that direction.

Q. But the details of it were not known? A. I think not. So far as I know about this, there has been no detailed description of the method or its operation, as of authority.

Q. It has not made its way into the literature of the art, as far as you know? It has not entered into the gas-literature of the day? A. It is not to be found, as far as I know, in any of the gas-literature of the day; I think the description which we have given in this discussion here, was the first which came before the public in a formal manner.

Q. When did you see it first yourself? A. I first saw it some time during last summer, perhaps it might have been in June.

Q. Then you first visited the works—first became acquainted with the fact that they had this method? A. I have been in the habit of visiting the Manhattan Works for a great many years, but I visited them for a knowledge of the new system of ventilation last summer; and more recently I have visited them again.

Q. At that time it was regarded by them as a success? A. Yes, sir. The Engineer spoke of it to me as being an experiment at the time.

Q. But subsequent experience has proved it to be measurably successful? A. Yes, sir. They are so well satisfied with it, that one of the officers told me last week, they contemplate the coming season to erect new sheds to cover the necessary revivifying boxes.

Q. They produce much more gas in the Manhattan Company than they do in the Metropolitan Company? A. I think four or five times as much.

Q. And use four or five times as much lime for purification? A. Yes, sir.

Q. Whatever there is offensive about the manufacture of gas—if there is anything offensive about effete lime—it would be magnified at the Manhattan Works? A. Yes, sir. My recollection is that they consume one bushel of lime to every 3600 or 3700 cubic feet of gas, and that the daily make of gas is 5,000,000 cubic feet.

Q. The oxide of iron at the New York Works was, you say, on the floor. A. Yes.

Q. It was not ventilated in the boxes? A. No, sir.

Q. And whatever was objectionable in regard to its emanations and exhalations went into the atmosphere? A. Of course.

Q. Of whatever character? A. Yes, sir.

Q. As you went there for the purpose of regarding the process in its economical bearing, you were sufficiently informed as to that? A. No, sir.

Q. You have been inquired of by Col. Hastings, as to the article of William Odling, Professor of Chemistry at Guy's Hospital, and the article has been put into your hands for examination. Now, sir, will you please to state, in what regard, if any, you differ from Prof. Odling in regard to that method? A. Dr. Odling has rehearsed with great detail the whole matter of the chemistry connected with the combustion of gas in houses, on the occasion of the recent meeting of the Metropolitan Association of Medical Officers of Health.

Q. How recent, Professor? A. At a meeting of the Board of Health held in Fleet-street, London, in January of this year, as I understand.

Q. Subsequent to the article (to which your attention has been called) of his, July, 1868? A. That article was the substance of an address which he gave before the British Association of Gas-Engineers. This is substantially the same as the former lecture, but is somewhat more in detail, as it is in print, particularly the consideration of questions connected with the consumption of gas in houses relative to domestic use. With his customary clearness and exactness of statement, Dr. Odling in this very interesting communication, which extends over five columns of the *Gas-Light Journal*, goes minutely into the consideration of all the important questions raised by the subject of discussion, and, among others, he rehearses what has been before quoted with respect to the amount of sulphur which is contained in gas; and following this communication is a discussion of the points of the lecture, in which Dr. Letheby, Mr. Hawksley, Mr. Findlay, and others took part. Dr. Letheby, whose name is even more intimately associated with the subject of gas-chemistry than is that of Dr. Odling, and who is the gentleman to whom we are indebted for some of our most important methods of analysis in gas-chemistry, takes exception to the remarks of Dr. Odling, in respect to the importance of the sulphur product resulting from the

combustion of gas, meaning thereby, of course, the products of sulphurous and sulphuric acids, which are evolved in its combustion. With your permission, I will submit a few of Dr. Letheby's remarks in detail. In the *Journal of Gas Lighting*, London, Feb. 2nd, 1869, page 83, he says: "And now I am desirous of making a few remarks on the effects of the sulphur in coal gas. Dr. Odling has directed your attention to this matter from a statistical point of view, and has shown you how, by a mathematical process, the amount of sulphur acids in the products of burning gas may be reduced to a vanishing point, and that, therefore, they must be insignificant and wholly harmless; but I will ask you to look at the subject from another point of view, and to examine it in the light of facts as well as of figures. About 15 or 20 years ago, when I began to inquire into this matter, I was struck with a circumstance which is now, as it was then, very remarkable—namely, that wherever gas is burnt continuously, and in large quantity, it causes a rapid destruction of textile fabrics, with a very acid condition of them. This is notably so in our public libraries, and in warehouses and shops. I obtained so many striking proofs of this, especially from the libraries of the Athenæum Club House, the London Institution, the College of Surgeons, and elsewhere, that I made them the subject of a special report to the city authorities in 1854, and here you will see the specimens of covers of books which were furnished to me at that time. If you apply a piece of the leather to your tongue, you will taste its acidity, and if it be treated with water or spirit of wine and tested with a solution of baryta, it will be found that the acid is sulphuric acid. These effects were observed many years ago, in the library of the Athenæum Club House, and they were growing to be so serious, that the managers requested a commission of chemists, including Doctor Prout, Mr. Aiken and others to inquire into it, and I have before me a copy of their report on the subject. It is to the effect that the mischief is clearly due to the presence of sulphuric acid, which had come from the burning gas; and they state that the mischief will continue as long as gas is used in the library without proper ventilation. Mr. Faraday thereupon designed the system of ventilation which is still used in the library. As to the effects of the products of burning gas on shop-goods, they are notorious, for such goods are regularly disposed of as damaged or gassy things. It has been remarked, too, that plants are quickly killed by the products of burning gas, for they are peculiarly susceptible of injury from the presence of sulphurous acid in the air; according to Drs. Christison and Farmer, as little as one part in 10,000 of air will kill plants in less than 24 hours. And you cannot use gas in a conservatory, either for heating or for illuminating purposes, unless the products of combustion are entirely removed. Dr. Christison has written to me very strongly on this subject; and he attributed the absence of flowers and plants from the rooms of Edinburgh to the circumstance that gas is universally used in them. Advancing a step further in my inquiries, I ascertained that the water produced by burning gas, collect it how you will, is always acid, and will rot leather, paper, cotton, and linen. Here are specimens of such tissues, which have been dipped in the condensed liquid products of gas combustion, and you will observe that they are as rotten as tinder. Lastly, I contrived a plan whereby the amount of sulphur in coal gas could be estimated. I had thought that the instrument was sufficiently well known, and the *rationale* of its action thoroughly understood; but the instrument which Dr. Odling has placed upon the table, and has described to you as my ingenious contrivance, is so different in all its essential particulars from my own instrument, that I disown it, and call it an ingenious perversion of the apparatus which bears my name. I know from experience that such an instrument will not discover half the sulphur that is really present in coal gas; and I have no doubt that the discrepancies which have lately been referred to by writers on this subject, have been occasioned by the use of such an instrument as is now upon the table. The particulars of my instrument, the measurements of the several parts of it, and the mode of using it, are fully described in Mr. Sugg's book on Gas Manipulation, and if it be used in a proper manner it will discover all the sulphur of the gas; and thus it will be found that the amount of sulphur may reach to from 30 to 40 grains per 100 cubic feet of gas. If the presence of sulphur in such quantity in coal gas was an unavoidable necessity and could not be reduced by any reasonable process of manufacture or purification, it would be folly to complain of it, other than to show the necessity for good ventilation where gas is burnt; but this is not the case, for there are processes of purification which will easily diminish the amount of sulphur to less than half the usual quantity. Mr. Hawksley, whose presence this evening will, I hope, be useful to us, by his giving us the results of his large experience in this matter, has shown that by copiously washing raw gas with ammoniacal liquor, it is possible to remove a large proportion of the sulphur compounds of gas without injuring in the slightest degree its illuminating power. After this treatment the gas should be deprived of its sulphuretted hydrogen by means of hydrated oxide of iron, and then while a little ammonia is still remaining in it, it should be further purified by passing it through dry lime, which is the slightly moistened hydrate of lime. In this way the ammoniacal liquor is strengthened to a high degree—it being rarely less than of 10 oz. strength—by the absorption of ammonia compounds, and by the removal of sulphur in other forms than that of sulphuretted hydrogen. The hydrated oxide of iron is also less foul that it usually is, and is capable of revivification, without annoyance; while the hydrate of lime is actually inoffensive, for it contains nothing but carbonic acid and sulphocyanogen and sulphur produced by the reaction of ammonia on bisulphide of carbon in the presence of caustic lime. Mr. Hawksley will tell you, what I also know from experience, that by these means the amoun of sulphur in coal gas is easily and certainly reduced to about 10 or 12 grains per 100 cubic feet of gas. It is easy, as I have said, to meet this question by a numerical argument, and to show by a mathematical process of reasoning that the amount of sulphur in gas may be made to vanish almost entirely; but I would rather examine the practical or experimental facts, and endeavor to remedy what is among practical men an acknowledged evil, by applying those remedies which are clearly within our reach."

In that connection I desire to present to your notice a quantity of sulphur by actual weight, such as the English law allows, viz, 20 grains of sulphur to each 100 cubic feet of gas.

[A weighed portion of 20 grains of sulphur was here offered in evidence, and package marked "Exhibit B."]

You will observe that it is by no means an insignificant quantity regarded as a material substance. I may say, that if that quantity of sulphur were suddenly burned in an atmosphere no larger than that in an ordinary sitting room, the air of the room would be insupportable. But it is worthy to be remembered that that quantity of sulphur is actually set at liberty in the form of sulphurous acid in about five hours' time in an evening, in a room which is lit by four ordinary gas burners of the capacity of five feet each, and that it is in evidence from Dr. Letheby and others, that the gas may even contain 30 or 40 grains in every 100 cubic feet. It is always to be remembered that the largest product in bulk which is given off in the burning of gas, is water in the form of watery vapor; and that this watery vapor takes up and absolutely retains sulphurous acid, and rests upon the windows, upon the paint, and upon the hangings, if there are any; and upon the books and bindings that are in the room, and that in the upper portions of the room it is especially noticeable, owing to the temperature, resulting from the combustion and the warmth of the room, that these products are most abundant.

In this connection Mr. Hawksley remarked, in the discussion before alluded to, that—

"He was enabled to state that by the use of ammoniacal liquors for the purpose of washing the gas and by the use of lime in the process of purification, the sulphur could be reduced without any sensible depreciation in illuminating power to as little as 10 grains in 100 feet, that was to say to as little as one half the quantity which was allowed by act of Parliament. Now, it might be said that this was not worthy the attention of professional men in that room. It was said, and said with some truth that the gas companies had been driven away from the use of a very valuable agent, by persons who complained that the use of lime in the purification of gas was a nuisance. They had consequently been driven to employ the oxyd of iron, which was a very imperfect agent for the removal of some of the compounds; and the general result was, that in order to free our streets from the occasional smell of foul lime, we put sulphur into our dwelling houses. He did not think it was any improvement in a social sense at all, and it was always desirable to ascertain whether, in effecting changes which might be proposed, and which might appear to be beneficial, we were not producing injurious effects in another direction. However, such had been the results. He did not think with regard to the question of the presence of ammonia, that any notice whatever, in the present state of the manufacture of gas, need be taken of that agent. The quantity was so small, even in the gas which was the worst purified, in the sense of the removal of ammonia, that he did not believe any effect at all—any appreciable effect—detrimental or otherwise, would arise, and he would say this with regard to the alleged effect of gas upon books and furniture, and other articles of that sort, that, although he believed there had been a considerable effect produced when gas was very much more purified than it was at the present day, yet he believed there were now other causes operating to produce the effect, which were at least as great as gas, if not greater. The quantity of coal consumed in London gave off more than 6000 tons of sulphur into the atmosphere every year, and so large a quantity as that, must in itself produce a very sensible effect, in point of fact, we know it. But besides that, we must not forget the influence of temperature. With a large quantity of gas burnt in a room, near the ceiling, unless special means of ventilation were adopted, the temperature would be very high indeed—so high that it would be impossible to exist in it for many minutes, perhaps not for one. Well, now, that had a very serious effect upon books and furniture, and he attributed very much of the rottenness of books—always greater on the higher shelves than on the lower—to that cause. He believed gas had been very largely discredited in consequence of other influences, which did not proceed from the combustion of gas itself."

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"Mr Findlay said he had been connected with two of the largest gas companies in London for sixteen or seventeen years, and he quite agreed with the remarks of Mr. Hawksley about the use of lime. It was a question whether they ought not to go back to the old practice. It was well known that there was no better process of purification than by means of wet lime or dry lime, it must always be a nuisance to a certain extent."

By *Mr Van Vorst:*

I don't know whether it was taken down or not, but I understood you to say in your cross-examination, that gas in London was not consumed in the dwelling houses to anything like the extent that it is consumed in the dwelling houses in this country. A. That was the case when I was familiar with London; and it is not to this day, as I am assured, esteemed fashionable to hold a ball, or reception or entertainment in the evening, with gas. The houses are lit then with wax-candles, and there is still a prejudice in London, to a great extent, against the use of gas in houses, to a much greater extent than is known on this country.

Q. Is there anything more you wish to say? A. I think the subject has received sufficient ventilation without trespassing on the time of the honorable Referee any further.

By Mr. Hastings:

Q. Is not the quantity of sulphur left in the gas after purification very largely caused by the kind of coal employed in the manufacture of the gas? A. Not necessarily. The amount of sulphur compounds produced is directly as the amount of sulphur in the coal, but the amount of sulphur left in the gas, depends largely on the method of purification. If the gas is improperly purified, of course the amount of sulphur it contains will be greatly increased. The difficulties and the cost of purification, and the time which is consumed in the act of purification, are all greatly increased by employing a coal which, in the technical language of the coal house, is dirty. Dirty gas is likely to be the consequence. There are many coals which, but for the large amount of sulphur they contain, would be very desirable indeed, as gas coals, but they are inadmissible, from the reason referred to. This remark is true of most Nova Scotia coals, some of which will yield as high as 4½ cubic feet of gas of excellent illuminating power, but by reason of the large amount of sulphur which the coal contains, it is found not economical or profitable to employ it. I beg leave, in this connection, as you have brought the subject up, to call your attention to an important paragraph in Clegg, which Mr. Chandler will at once remember. On page 197, he states in a single instance that "one of the anomalous results obtained in the experiment—alluding to experiment made by Mr. Palmer and Mr. Elkison, which you have already quoted—"that the quantity of sulphur present in the coal does not bear any proportion to the sulphurous compounds in the gas produced from it."

Q. Other things being equal, would not a coal containing 20 per cent. of sulphur, yield a gas containing more sulphur products than that produced from a coal containing only 10 per cent.? A. I conceive that the answer to that inquiry is properly conveyed in my former answer. The quantity of sulphur products would of course be in proportion to the amount of sulphur contained in the coal, but that which would remain in the gas would not be necessarily greater. In this paragraph which I have just quoted is a single sentence perfectly in point: "Thus it appears that the gas obtained from the Denain coal, from the neighborhood of Valenciennes, which contains 31.10 pounds of sulphur in one ton, gave a maximum of 7.48 grains of sulphur per 100 cubic feet, while the gas from Stavely coal containing 26 pounds of sulphur in one ton, yielded 22 grains of sulphur to 100 cubic feet of gas." It appears, therefore, in answer to your question, that there is no direct ratio between the amount of sulphur contained in the coal and that which will be found in the gas—that the coal which contains a less proportion of sulphur as an original constituent, than another coal, may yield a gas which contains less sulphur by constitution than the gas produced from another coal containing a larger amount of sulphur.

Adjourned to Saturday, February 20th, at one oclock.

—About 4,500 work-people are engaged in the neighborhood of Dudley, in England, in the manufacture of chains, cables and anchors. Over 60,000 tons of chains and cables, and 5,000 tons of anchors are produced annually.